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THE EFFECT OF INFLATION TARGETING ON MACROECONOMIC PERFORMANCE IN GHANA

BY

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DECLARATION

I hereby declare that this work is the results of my own investigations and that apart from the works of those which have been dully acknowledged in the text, this work has never been presented to this University or any other university elsewhere for the award of any certificate, diploma or degree.

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DEDICATION

To my Mum and Siblings

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ABSTRACT

Inflation targeting was adopted in Ghana in 2002 after the Bank of Ghana Act, 2002 (Act 612) gave the Bank the operational and goal independence to pursue such a monetary policy framework. Despite Ghana practicing the policy for over a decade now, there has not been extensive research on the macroeconomic effect of the policy. This study investigated the effect of inflation targeting on macroeconomic performance in Ghana focusing on four key macroeconomic variables; the inflation rate, exchange rate, interest rate and the growth rate of output. The study employed the regression analysis, Granger causality test, the Johansen cointegration and the vector autoregressive estimation approaches.

The study found that inflation targeting has reduced both the growth rate and variability in inflation rates. There have also been reductions in growth and variability in the interest rate although the interest rate still remains high in Ghana. The policy doesn't seem to, however, have any effect on the exchange rate as there has been continuous depreciation of the Ghana cedi even in the targeting period. The study also found a tradeoff between inflation rate and growth rate of output in Ghana indicating that inflation targeting does not come at a cost in terms of reduction in the growth rate of output. The variability of growth rate of output has, however, increased in the inflation targeting period.

The study concludes that inflation targeting has positive effect on the macroeconomic performance in Ghana. The policy has performed creditably but has not yet delivers the price stability goal. Achieving this policy goal has been slow due to higher inertia and persistence in the price variables and weak long run relationship among them. In order to deal with the continuous disturbing trend of exchange rate depreciation in Ghana, the Bank of Ghana needs to include the exchange rate as a target variable in the policy reaction function.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AD	Aggregate Demand
ADF	Augmented Dickey-Fuller
AfDB	African Development Bank
AIC	Akaike Information Criterion
AS	Aggregate Supply
AYINF	Actual Year-on-Year Inflation Rates
BRATE	Base Rate
BoG	Bank of Ghana
CPI	Consumer Price Index
GDP	Gross Domestic Product
AGDPGR	Actual GDP growth rates
ECOWAS	Economic Community of West African States
EXCRATE	Exchange Rates
FLTR	Forward Looking Taylor's Rule
FPE	Final Prediction Error
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GSS	Ghana Statistical Service
HQ	Hannan-Quinn
IMF	International Monetary Fund
INTRATE	Interest Rates
InfTag	Inflation Targeting
LAS	Long Run Aggregate Supply
MoFEP	Ministry of Finance and Economic Planning
MPC	Monetary Policy Committee

OLS	Ordinary Least Squares
RGDP	Real Gross Domestic Product
RGDPGGAP	Real GDP Growth Gap
PPI	Producer Price Index
SAS	Short Run Aggregate Supply
SC	Schwarz Information
SUR	Seemingly Unrelated Regression
SVAR	Structural Vector Autoregression
VAR	Vector Autoregression
VECM	Vector Error Correction Model
YINFGAP	Year-on-Year Inflation Gap

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Prior to the 1990s, monetary policy regimes in developing and emerging market economies largely comprised of monetary aggregates targeting and exchange rate targeting. The goals have been varied; from price stability, stimulation and reduction of fluctuations in aggregate demand and supply, ensuring overall conducive macroeconomic environment, to stimulating economic growth. As such, the focus has always been on targeting and/or influencing money supply, short-term interest rate or nominal exchange rate.

However, a new era in the practice and trends of monetary policy dawned in the early 1990s with the emergence and growing influence of the inflation targeting framework. Inflation targeting is defined as "a framework for monetary policy [such that] price stability is explicitly recognized as the main goal of monetary policy" (State of the Art of Inflation Targeting, Bank of England, 2012). The policy framework has general identifiable features as credibility, independence, transparency and a focus on inflation in the conduct of monetary policy.

The inflation targeting is fast becoming a preferred monetary policy framework in developing nations, especially in emerging market economies, after it's seemingly success in the developed nations like New Zealand, UK and Canada who initially adopted it. Petreski (2010) noted that inflation targeting presents a real switch in developing nations and as a result, it has been argued that the monetary policy of these economies now features a more independent monetary policy conduct, more stable macroeconomic environment and a strict focus on inflation.

Inflation targeting countries seem to have reduced the rate of inflation and inflation expectations to levels that wouldn't be possible without the framework (Mishkin and Posen, 1998). According to Wampah (2012), "Ghana adopted the inflation targeting framework since 2002 and has significantly reduced both the rate of inflation and inflation expectations."

Prior to 1983, the Bank of Ghana largely used direct monetary controls. This involved the use of direct instruments, predominantly credit and interest rate controls (ceilings) to control credit to certain sectors and the economy as a whole. Credit ceilings were imposed on individual commercial bank's lending to certain sectors. This was done in consonance with government targets of economic growth, external balance, inflation, exchange rate, and the overall macroeconomic performance targets. These policies however proved ineffective with time as macroeconomic performance worsened over the years.

The economic recovery programs of the 1980s came with liberalization in certain sectors of the economy. The financial sector was one of such sectors with the financial sector liberalization program. This saw the modification of monetary policies by the Bank of Ghana to suit the liberalized financial environment, and hence direct controls were abandoned.

From 1992, indirect instruments were the focus of monetary policy in Ghana. These included monetary targeting (money supply, interest rate and exchange rate controls). The Bank of Ghana has been informally operating the inflation targeting framework since 2002, and formally adopted it in May 2007, making Ghana among the first of the emerging market economies in the world to have officially adopted it, and the first low income country then to have done so.

The Bank of Ghana Act, 2002 (Act 612) seems to have prepared the grounds for the adoption of the inflation targeting framework. The act states that, ''the primary objective of the Bank is to maintain stability in the general level of prices. Without prejudice to the above, the Bank

shall support the general economic policy of the Government and promote economic growth and effective and efficient operation of banking and credit systems in the country, independent of instructions from the Government or any other authority.'' The act also directly tackled the recurring problem of fiscal dominance by placing a ceiling on the limit of public borrowing in a fiscal year (Act 612, section 30, subsection 2). It also provided for the establishment of the Monetary Policy Committee (MPC) (section 27) to direct monetary policy setting. This legal framework granted the Bank both the goal and instrument independence which are pre-requisites for successful adoption of the policy framework.

The Bank of Ghana is more of flexible bias than the strict form of inflation targeting. The Bank responds not to only variability in inflation, but is also concerned about variability in the real exchange rate and interest rate. For instance, the direct responds of the Bank to the consistent and significant depreciation of the cedi in the latter part of 2011 well to the last quarter of 2012 was strong enough to attest to the concerns of the bank to fluctuations in the real exchange rate.

Inflation targeting with managed floating exchange rate regime and a market determined interest rate is practiced in Ghana. The exchange rate is determined by market forces, although remotely managed by the Bank of Ghana. The experience of exchange rate management in Ghana suggests that the rate seems to be exposed to severe volatility, especially within the relatively shorter period of adoption of the inflation targeting framework which has seen the cedi more of deteriorating in value than appreciating. In essence, the cedi is almost all the time salvaged by the Bank of Ghana. The short-term base rate serves as the policy instrument which has effect on the interest rate. The interest rate is also influenced by market conditions aside the short term policy rate.

In this study, measuring macroeconomic performance focuses on the effect of inflation targeting on four key macroeconomic variables; inflation rate, interest rate, exchange rate, and growth rate of output. As a developing and emerging market economy in a highly volatile inflationary sub-region and relatively new entrant into the group of inflation targeting countries, it is important to investigate the effect of inflation targeting on macroeconomic performance in Ghana. The study therefore examines the effect of this monetary policy framework from 2002 to 2011. The study employs statistical analysis, regression estimation techniques, the Granger causality test, the vector autoregression analysis and the Johansen Cointegration approaches.

1.2 Statement of the Problem

The economy of Ghana normally experiences a phenomenon where despite a consistent and significant reduction in inflation rate, the exchange rate deteriorates significantly as experienced in 2011 and 2012. This affects stability and causes apprehension in the financial sector. The interest rate also seems to remain unresponsive to declining rate of inflation. This reveals the need to empirically evaluate the effect of inflation targeting as the monetary policy framework on the actual inflation rate, interest rate and exchange rate.

The tradeoff of inflation and output/unemployment has sparked off a lot of debate in the formulation of macroeconomic policies in developing nations. There is a dilemma on the part of policy makers of whether to stimulate output and accommodate a certain level of inflation, or target inflation and hurt a possible growth rate in output. The debate is even more intense as to whether the tradeoff is short or long run phenomena as the distinction between short run and long run tradeoff seem somewhat blurred. Empirical studies have also been inconclusive, and often found it difficult to analyse and defend the long held claim of short run but no long

run tradeoff between output and unemployment partly as a result of the dynamics of different economies. So is there any tradeoff between inflation and output in Ghana? Is there evidence of output growth variability that can be attributed to inflation targeting?

The academic literature generally views inflation targeting as a regime for advanced countries given the historical background of the framework. There have been extensive debates on the framework focusing on the advanced industrial nations. As far as developing nations particularly those in sub Sahara Africa are concerned, there has not been intensive research on the macroeconomic effect of inflation targeting probably because these countries are relatively new entrants into the inflation targeting group. Much less studies have been done on the effect of the policy framework on the growth and volatilities of actual inflation, exchange rate, interest rate and growth in output. This study therefore seeks to investigate the effect of the inflation targeting monetary policy framework on these variables.

1.3 Objectives of the Study

The major objective of this study is to examine the effect of the inflation targeting framework on macroeconomic performance in Ghana using a time series data set from 1992 to 2011.

The study has the following specific objectives:

- To investigate the effect of inflation targeting on the actual inflation rate,
- To examine the effect of inflation targeting on exchange rate,
- To estimate the effect of inflation targeting on interest rate,
- To examine the effect of inflation targeting on output growth and variability.

1.4 Hypotheses of the Study

Within the context of investigating the effect of the inflation targeting framework on macroeconomic performance, the main hypotheses of the study are five, as follows:

1) H_0: Inflation targeting has no effect on actual inflation

   H_1: Inflation targeting has effect on actual inflation

2) H_0: Inflation targeting has no effect on exchange rate

   H_1: Inflation targeting has effect on exchange rate

3) H_0: Inflation targeting has no effect on interest rate

   H_1: Inflation targeting has effect on interest rate

4) H_0: Inflation targeting has no effect on growth in output

   H_1: Inflation targeting has effect on growth in output

5) $H_{0:}$ There is no tradeoff between inflation and growth in output

   $H_{1:}$ There is tradeoff between inflation and growth in output

1.5 Justification of the Study

Assessing the success of monetary policy in terms of its effect on macroeconomic performance has been a focus of economists for decades. Despite the large amount of existing theoretical and empirical literature, there exist no clear cut answers on the effects of monetary policy on aggregate economic activity (Sims, 1992). This is as a result of the different dynamics of economies and the choices of monetary policy.

Conducting an empirical assessment of the effect of the inflation targeting framework is an important research exercise for monetary policy evaluation and possible modification. As pointed out by Bernanke and Mihov (1998), accurate estimation of monetary policy is

important for both policy makers for practical reasons and researchers for analytical reasons. Obviously, the effectiveness and efficiency of monetary policy depend on the accurate assessment of the effect of the policy on the economy, and this study does just that.

The study can therefore be of principal interest to both government and monetary authorities for policy and planning. It will help stakeholders to formulate monetary and fiscal policies capable of enhancing economic growth and effectiveness and efficiency of monetary and fiscal policy instruments. Again, the results of the study can serve as a guide to constructing appropriate monetary and fiscal reforms and evaluating the effectiveness of these reforms to achieve more competitive, healthier, efficient and stable monetary systems, and enhance fiscal performance to ensure stability and sustainable economic growth.

There exist few empirical studies on the inflation targeting framework in Ghana. The study will therefore add to the existing literature and stimulate further research. The study will also help address the inherent methodological problems associated with the estimation of the effects of the policy framework in developing and emerging market economies.

1.6 Scope of the study

The focus of the study is on the effect of inflation targeting on only inflation, exchange rate, interest rate, and growth in output as a measure of macroeconomic performance. The study focuses on the period of 1992-2011.

The study does not cover the issue of the suitability of inflation targeting to the Ghanaian economy, or the implementation process and challenges of the framework. It does not also cover the issues of accountability, transparency and credibility of the Bank of Ghana.

1.7 Organization of the Study

The study is organized into five chapters. Chapter one contains the background, problem statement, justification and scope of the study. Chapter two presents the review of related literature. The literature review concentrates on the definitions and evolution of inflation targeting, inflation targeting in Ghana, the theoretical literature and the empirical literature review. The empirical literature review is sub-divided to studies on inflation targeting and other related studies.

Chapter three presents the methodological and conceptual framework of the study. It includes model specification, estimation procedure, data sources and measurement of variables. Chapter four presents the empirical results and discussions. Chapter five, which is the final chapter presents summary of major findings, recommendations and policy implications and the limitations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter presents a review of related literature on the inflation targeting framework and its effect on macroeconomic performance. The chapter is divided into three main sections. The first section presents the general overview of the framework. This includes the background of the evolution, definitions and overview of inflation targeting.

The second section of the chapter presents the theoretical models and debates about the dynamics of inflation. This specifically includes theories of the causes and costs of inflation and the relationship of inflation and other macroeconomic variables such output, exchange rate and interest rate. This section also presents models and policy frameworks of disinflation from various theoretical perspectives.

The final section presents the empirical studies on the inflation targeting framework. This section is sub-divided to empirical studies on inflation targeting and other related empirical studies. Since the story about the framework has been about its evolution over the past two decades, the empirical literature is organized chronologically.

2.2 Definitions and Evolution of the Inflation Targeting Framework

This section presents the general overview of the definitions and evolution of the inflation targeting framework. The overview is both from theoretical and empirical perspectives.

2.2.1 Definitions of Inflation Targeting

Inflation targeting is defined on two grounds- in terms of policy rules or in terms of observed characteristics of the policy framework. On the first option, inflation targeting is described as optimal policy rule derived from an explicit objective function (Svensson 1997, 1999, 2010; Walsh, 2002; Woodford, 2004).

Svensson (2010) defined inflation targeting as "a monetary-policy strategy that is characterized by an announced numerical inflation target, an implementation of monetary policy that gives a major role to an inflation forecast and has been called forecast targeting, and a high degree of transparency and accountability." Inflation targeting is highly associated with an institutional framework that is characterized by the trinity of (1) a mandate for price stability, (2) independence, and (3) accountability for the central bank (Svensson, 2008).

On the second option, Bernanke et al (1999) described inflation targeting as a "framework" rather than a "rule". They defined inflation targeting as: "a framework for monetary policy characterized by the public announcement of official quantitative targets for the inflation rate over one or more time horizons, and by explicit acknowledgment that low, stable inflation is monetary policy's primary long-run goal."

Kuttner (2004) argued that any "sensible" definition of inflation targeting should bear the following "four hallmarks": 1) a stated commitment to price as the main goal of monetary policy, but need not be the only goal; 2) an explicit numerical target inflation figure and a horizon; 3) high degree of transparency in the conduct of monetary policy; and 3) mechanism for accountability. Mishkin (2004) in addition to these four characteristics included the fifth one: "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".

Svensson (2007) identified three characteristics of good inflation targeting framework. (1) It does not only consider stability of inflation around the target but stability of the real economy in terms of stability in real variables such as the output gap. (2) There is an internal decision process -"forecast targeting" - in which projections of the target variables are assigned a prominent role and the central bank sets the instrument rate such that the target variables "looks good" relative to the monetary policy objectives. Target variable are the variables used to augment the central bank's implicit or explicit loss function and the instrument rate is the short-term interest rate that is used as instrument or operating target. (3) There is a high degree of accountability and transparency in the conduct of monetary policy. In order to achieve effective implementation of its policies and rigorous external scrutiny of its performance, the central bank needs to be opened about its internal projections and give detailed explanation about the motivations of them and its policy instruments decisions.

Svensson (1999) coined two types of inflation targeting- strict and flexible inflation targeting. Flexible inflation targeting is not only concern about stability in the inflation rate around the target, but stability in other real economic variables and the overall economy. Under strict inflation targeting, the central bank will keep to its target of inflation very closely. This process will involve very rigorous monetary policy conducts involving changes in interest rate and exchange rate. Ultimately, they will be variability in real variables such as the output gap, interest rate and the exchange rate as well as fluctuation in aggregate demand and supply within the short-term horizon, all in a bid to stabilise inflation around it target trend. Adoption of strict or moderate inflation targeting depends on the initial conditions of the economy and mainly on the economic objectives of the monetary authorities. These influence the nature of the loss function of the central bank.

Carare and Stone (2005) categorised three types of inflation targeting countries base on the clarity and commitment of the central bank to inflation as the nominal anchor. They distinguished between three different kind of targeters; full-fledged inflation targeting (FFIT), implicit price stability anchor (IPSA), and inflation targeting lite (ITL). The (FFIT) are those with medium to high level of credibility and clear commitment to inflation as the nominal anchor with institutional commitment to transparency and accountability in the conduct of monetary policy.

Implicit price stability anchors (IPSA) are without full commitment to inflation but with high degree of anti-inflationary credibility and no full accountability and transparency with respect to the inflation target. These countries have record of low and stable inflation and high degree of financial stability that afford them the flexibility to pursue output stabilization as well as commitment to price stability.

The ITL countries have broad inflation objectives but low credibility and commitment to inflation. Because of the relatively low credibility of these ITL countries, they have weak institutional structures which make them vulnerable to financial instability and economic shocks. All the countries under the ITL group are identified as emerging market economies. Truman (2003) however has a problem with this kind of classification describing it as a "dressed-up self declaration".

The inflation target can be with a short term or long term horizon. The implicit target horizon is the time taken for the expected inflation to return to the inflation target following a permanent or unexpected disturbance or shock. The time horizon reflects the long and variable lags in the monetary policy transmission mechanisms. Naturally, the length of the target horizon is positively related to the magnitude of the shock and the degree of persistence of the effects. It is also positively related to the output fluctuations in the central

bank's objective function. The central bank's output stabilization process has crucial effect on both the determination of the short term interest rate and the speed with which the inflation rate adjusts towards its target after the shock. The policy preference will obviously affect variability of output and inflation.

According to Mishkin (2000), shorter-time horizon like that of one year may lead to complexities and policy control problems. There can be frequent misses of the targets even with optimal monetary policy, and this can reduce the central bank credibility and induces high inflation expectations. Shorter-term horizon can also lead to instrument instability as there will be frequent shifts in policy instruments in other to achieve a long-term target within the short-term horizon. Short-term horizon also puts greater weight on inflation and less aversion towards the short-term output fluctuations in the loss function of the central bank. This could deprive monetary authorities of the public support.

So what is the optimal horizon for the inflation target? Mishkin (2000) advocated for two years ahead horizon. This then means that the central bank will have a multi-year target, so that targets could vary overtime. Lengthening the time horizon gives the central bank the time to effectively manage output fluctuations (Mishkin, 2005). An opened time frame assists the central bank to avoid excessive fluctuations in their instruments. Having a multiple targets with a two-year ahead inflation target horizon allows for variation in targets to accommodate shocks to the economy, especially supply shocks which may need accommodation in other to forestall possible fluctuations in output. Public understanding of the target horizon is also critical.

Batini and Nelson (2001) identified and defined two types of optimal horizons base on the inflation target model; optimal feedback horizon and optimal policy horizon, to investigate the optimal horizon for inflation target in the UK. They defined optimal policy horizon "as

the time at which inflation should be on target in the future when the authorities aim at minimizing their loss function, and a shock occurs today", and the optimal feedback horizon is defined as "a simple feedback rule on expected future inflation, for which the authorities should form a forecast for inflation to use in the rule." Their results suggested that it is optimal to recover shocks over a period of 8-19 quarters for the optimal policy horizon. For the feedback horizon, they suggested that the "best horizon to focus on depends crucially upon the degree of forward-looking behaviour in the economy."

Another critical issue in the definition of inflation targeting is whether to adopt point targeting or range targeting. The advantages of range targeting as identified by Mishkin (2000), are that it provides for more flexibility to the targeting regime and also gives the public an explicit message of uncertainty in the inflation forecasting and disinflation process and therefore the imperfectability of the central bank.

However Mishkin also argued that range targeting may confuse the public and reduce the credibility of the central bank, particularly in developing nations where the public already have less esteem for state institutions. In the case of developing countries like Ghana, uncertainties about the inflation process is greater which makes the probability of missing a narrow target even higher. Developing countries, especial emerging market economies either choose a point target with a range around it or a target range with a target point. The range is always +/-1 in most countries with some few exceptions like Brazil. The target range can also be narrow as 1% and wide as 8% (Levin et al, 2004). Target points are more fixated on inflation, and having a range around it allows for flexibility.

A simple numerical target (with tolerance limits) instead of a range has the risk that the upper tolerance limit rather than the midpoint will be interpreted as the target which could make inflation expectations anchored at high inflation rate defeating the original rate intended or

anticipated by the central bank (Pétursson, 2004). This could make disinflationary efforts very difficult. Narrowing the range as noted above will also have the disadvantage of frequent overshoot of the limit which can hurt the central banks credibility. Tolerance limits could also constrain the central bank policy response or effective reactions since the limits are interpreted as acceptable of inflation rate and that monetary policy should only react or respond to inflation if it approaches the limits. This is even more likely in developing and emerging market economies with experiences of high volatility in inflation.

The numerical target for advanced countries is typical around 2 percent annual rate for CPI or core CPI; in the form of range, such as 1-3 percent; or target as 2 percent point target with a range/tolerance interval of +1, or a point target without explicit range. Numerical target for developing and emerging market economies are usually percentage point higher than 2 percent.

Mishkin (2000) argued for point targeting for better performance of the inflation targeting framework provided the central Bank is well committed to effective communication with the public about the short run uncertainties in the disinflationary process. Point targeting may limit policy flexibility but the central bank can perform comfortably by communicating to the public about the inherent difficulties and uncertainties of the disinflationary process so that they can get the needed flexibility as well as public support and credibility.

Many central banks adopt the framework as an alternative to failed monetary policy rather than response to new policy thinking (State of the Art of Inflation Targeting, Bank of England, 2012). So far, empirical literature has given the framework high marks. It has been successful in reducing inflation and inflation expectations and volatilities in most nations with little or no economic cost in terms of sacrifice of output growth and/or increase in unemployment.

2.2.2 Evolution, Rationale and Pre-conditions of Inflation Targeting

The inflation targeting policy framework is generally borne out of the monetary policies of the developed world. New Zealand was the first country to officially adopt the framework in 1990. Then Canada and England followed in 1991 and 1992 respectively. By the end of 1993, formal inflation targeting countries increased to five, and by five years later the number had increased to ten (Monetary Bulletin, 2007-2). By the beginning of 2012, some 27 nations were considered practising the fully fledged inflation targeting framework and several others were in the process of adopting a full inflation targeting regime (State of the Art of Inflation Targeting, Bank of England, 2012). This story looks like a very rapid revolution of the framework, but Mishkin (2006a) argued that inflation targeting "is not revolutionary, however: rather it is a refinement of what has gone on before."

Countries adopt the inflation targeting framework base on varied reasons. These ranges from the search for new nominal anchor, dissatisfactions with earlier anchor in terms of macroeconomic performance, to the need for accountability and transparency in their monetary policy conduct.

Mishkin (2006b) identified six factors that may have led to advances in monetary policy conducts and improved performance of monetary policy as well as the rapid evolution of the inflation targeting framework. These factors include; "1) there is no long-run tradeoff between output (employment) and inflation; 2) expectations are critical to monetary policy outcomes; 3) inflation has high costs; 4) monetary policy is subject to the time-inconsistency problem; 5) central bank independence helps improve the efficacy of monetary policy; and 6) a strong nominal anchor is the key to producing good monetary policy outcomes"

The evolution and development of inflation targeting seems more of a reaction to dissatisfactions of the performance of earlier monetary regimes. One striking breakthrough in the understanding of the conduct and the transmission mechanisms of monetary policy was as a result of the rational expectation theories which led to the understanding of the time inconsistencies problem of monetary policy. The time in consistency problem shows that monetary policy conducted on continuous discretionary basis could lead to poor macroeconomic performance in the long run because policy authorities will be unable to follow optimal path overtime. Thus the optimal path will be time inconsistent and hence abandoned.

One way to prevent the time inconsistent problem of policy is to have a strong nominal anchor to restrict the central bank from pursuing short term expansionary policies that are clearly inconsistent with long run goal of price stability. It is however important to note that the decisions to embark on time inconsistent policies or not depend largely on the central bank. Although the central bank may be fully aware of the problem, but may bow to political pressures or pure populism, and chose to pursue such policies to exploit the possible short term tradeoff between inflation and unemployment.

The issues of time inconsistence problem of monetary policy, increasing recognition for central bank independence, the problems associated with other nominal anchors like monetary and exchange rate targeting, and the need for better nominal anchor led to a continuous search for better monetary policy options giving birth to the inflation targeting framework in the early 1990s.

Some economists argue that the inflation targeting framework is not a new born, but it actually evolved from monetary targeting by adopting the latter's successful elements such as commitment to price stability as long run policy goal, and transparency and accountability in

monetary policy conduct. Inflation targeting is however remarkably different from monetary targeting in two ways. 1) It announces a medium term numerical inflation target rather than a monetary target. 2) It makes use of all inclusive information strategy and reduces the role for intermediate targets.

Inflation targeting also possesses some advantages over monetary targeting. Mishkin (1998, 2006b) identified several of them: 1) it does not rely on a stable and continuous relationship between money and inflation. This makes large velocity shocks irrelevant to monetary policy performance. 2) It makes uses of information set comprising several relevant variables not just a single variable to determine the best setting for monetary policy. Using all inclusive information and not just one variable in monetary policy setting can make inflation targeting a better monetary policy over monetary targeting. 3) The public and markets readily and easily understand inflation targeting because they immediately relate and react to changes in prices unlike in the case of monetary targeting which they cannot easily experience and relate to. 4) Inflation targeting can offer more accountability and transparency because it associates with the public and the fact that it professes a clear monetary policy objective than monetary targeting. In the case of monetary targeting, once the relationship between inflation and money breaks down, accountability and transparency becomes very difficult for the central bank. 5) The inflation targeting framework reduces the political pressures on the monetary authorities to pursue inflationary policies. This reduces the tendency of time-inconsistent policy making. 6) The inflation targeting framework does not ignore traditional stabilizing goals such as fluctuations in output and employment and volatilities in other key sectors such as the financial sector.

The debates in monetary policy under the inflation targeting regime makes the central bank focus on what it can do, i.e. controlling inflation and not what it cannot do, i.e. persistent

increase in employment and output. The political debates now focus on these two options. Inflation targeting allows for what Bernanke et al (1999) described as "constrained discretion". It does not follow a rigid rule but allows for a degree of flexibility. It however ultimately constrains the central bank from overly expansionary or contractionary monetary policies. It also focuses on the long run output stabilization but allows for a mechanism to react to short term fluctuations. Inflation targeting helps deal with supply shocks by adopting gradualist approach to inflation control to be able to achieve the target in the long run with the very possible minimum distortion, if any at all.

In the assessment of Mishkin (2006b), inflation targeting has acquitted itself very well in its short years of existence. It has never been abandoned by any nation for non performance. It has been successful in proving price stability as a better nominal anchor. It has been successful in reducing inflation and interest rate levels as well as stabilizing output growth rate, exchange rate and interest rate. In the case of exchange rate for instance, it has weaken the pass-through in some advanced and emerging market economies alike. It has also reduced inflation persistence and inflation expectation in some target economies.

There are identifiable economic conditions assumed suitable for the inflation targeting framework, the so-called pre-requisites for adoption of the fully fledged inflation targeting framework. Most targeting nations rarely have all these conditions in place before adoption, but take steps to achieve them as they move along with the policy regime. The pre-requisites include; 1) the focus on inflation as the main goal of monetary policy. This means the absence of any other conflicting fiscal or monetary policy goal for the central bank. 2) To achieve the first point will require the central bank to be independent at least in the pursuance of its policy goals. 3) In pursuance of the first and second points, the central bank needs to be transparent and accountable.

Any inflation targeting framework should explicitly state price stability as the main goal of monetary policy. Pétursson (2004) noted that putting price stability as the ultimate goal of monetary policy does not mean that it is the most important and critical than any other macroeconomic objective, but it simply shows what monetary policy can do and what it cannot. As the main goal of monetary policy, price stability also serves as a nominal anchor. It also defines what the central bank can achieve in the long run thereby insulating it from political pressures to embark on time inconsistent policies.

The central bank independence measures the extent to which central banks can conduct monetary policy without having to respond to government economic decisions (Gartner, 2006). The independence of the central bank can be evaluated on the following basis as identified by Pétursson (2004): 1) the legal mandate of the central bank to define its objective and focus on the price stability; 2) the level of access of the treasury to direct funding from the central bank; 3) the ability of the central bank to change its monetary policy without government interference; 4) the role of the central bank in setting and controlling policy goals and instruments without government interference; and 5) the legal mandate and terms as well as conditions of appointment and dismissal of the central bank governor.

Central bank independence can be looked at from two options; goal independence and instrument independence (Mishkin and Schmidt-Hebbel, 2001; Truman, 2003). The instrument independence is considered to be more important than the goal independence in the central bank's conducts of monetary policy. The bank requires independence in the use of instruments and also the technical capabilities and knowledge of monetary policy transmission mechanisms to be able to set accurate and reasonable intermediate targets for the framework.

According to Mishkin and Schmidt-Hebbel (2001), the probability of a country's adoption of inflation targeting increases with the level of independence of the central bank since central bank independence is more appealing to the success of the framework. They further argued that goal independence significantly reduces the central bank's likelihood of adoption of inflation targeting, whilst instrument independence increases it. Truman (2003) did not, however, find any significant relationship between central bank independence and the likelihood of adoption of the framework whilst, Gerlarch (1999) argued that central bank independence is negatively related to the probability of adoption of inflation targeting.

The independence of the central bank could also be a norm or convention without any legal backing as in some countries. It could be gained by public support and understanding of the mandate of the bank and what monetary policy can do and cannot. Independence can insulate the bank from political pressures to pursue time inconsistence policies. This is why central bank independence is thought to be positively related to macroeconomic performance.

Central bank independence can also streamline the decision making process and implementation of the framework. As a result of independence in instruments and goal, and to deepen transparency and accountability, the central bank can allow for important decisions making process to be delegated to unelected experts. Most central banks appoint a committee with several and diverse expertise in monetary policy and economic dynamics so as to capture different shades of opinion of the state of the economy and future prospects. Policy committees are deemed to achieve better economic results with good designs of monetary policies than individual governors can do. In Ghana for instance, the central bank allows government to appoint some members to the monetary policy committee which sets the policy rates for the bank.

Another key feature of all inflation targeting regime is the enormous stress placed on transparency and communication with the public and markets. According to Bernanke et al (1999), "an essential element if not the most essential element about inflation targeting is transparency." The central bank has to be in constant communication with the government and markets through both formal and informal means.

Inflation targeting has taken transparency and communication in monetary policy conduct very high as compared to other frameworks. Targeting central banks have embarked on innovations in communication like periodic publication of inflation reports and forecast. These publications are also constantly been improved upon and made reader-friendly to the public with detailed contents of clear objectives of the central bank's policy instruments, limitations of monetary policy and some even contain the short run output forecast. Publishing central bank reports affords the government, policy experts, academia, and the markets the opportunity of analysing the central banks credibility and capability of attaining the policy target. It also enriches the policy debate.

Accountability and transparency in monetary policy conduct improve private sector planning as uncertainties in inflation and exchange rate fluctuations are lowered, improved monetary policy debates and recommendations for improvements. Monetary policy then becomes more predictable to dampen volatilities in interest rate, inflation rate and exchange rate thereby increasing the central banks credibility. All these help reduce pressures on the central bank as its role is made very clear to the public and, especially, politicians about the conduct of monetary policy and what it can achieve in the long run thereby reducing the time inconsistent problem.

There is also the need for conducive macroeconomic environment especially stability in the financial sector. Overall economic stability- stability in exchange rates, fiscal stability and

discipline, less external deficits and adverse shocks- afford the central bank to concentrate solely on inflation and set the conditions for successful achievement of the inflation target. A stable, efficient and effective financial system which includes stability and reliability of fiscal, financial and monetary institutions is crucial for the framework so as to make the monetary transmission mechanisms of the central bank very effective and efficient. Weak institutions offers a very poor environment for the framework because operating a full-fledged inflation targeting under such economic environment could lead to serious financial and currency crisis leading to contractions in economic performance (Mishkin and Calvo, 2002).

In their methodology for of classifying inflation targeting countries into three regimes, Carare and Stone (2006) emphasised the importance of stable economic environment for inflation targeting. They ignored small and less developed nations, even if any, with the explanations that these nations are mostly with underdeveloped financial sectors and less diversified opened economy, hence will readily find exchange rate targeting as a monetary policy framework more appealing than inflation targeting.

Truman (2003) found that improvement in fiscal stability increases a country's probability of adoption of the framework. Furthermore, experiences of a country macroeconomic performance and currency and financial crisis increases its probability of adoption of inflation. The level of advancement of the financial systems is also associated with the likelihood of the adoption of the framework.

Experience of the actual adoption and implementation of the inflation targeting framework demonstrate that although these conditions are desirable and considered pre-requisites, not all of them should necessarily be achieved in advanced before the framework can be adopted. As noted by most economists, these conditions are not necessarily appealing to only the inflation

targeting regime but any other monetary policy framework. Experience actually shows that countries who did not meet all the pre-conditions before adopting inflation targeting perform better. Gradual approach to meeting these conditions seems to be the norm for most countries (Pétursson, 2004).

2.2.3 Inflation Targeting in Ghana

The monetary policy objective of the inflation targeting policy in Ghana as in many regimes is price stability. The BoG pursues this objective by trying to ensure low inflation rate through achieving the government's yearly inflation targets in the annual budget statements. The inflation targets in Ghana normally have a one year horizon. The targets are revised annually with a general desired target of less than 10%.

The BoG pursues the objective of price stability through setting the interest rate- the policy rate. By the Bank of Ghana act, 2002, the Bank has the independence to set the interest rate in order to control inflation. Although, a given inflation target does not imply that the Bank should achieve the target at all cost or the inflation rate should be held constant at the target; but when the bank fails to achieve the target over a long period the MPC can steer the interest rate in order to bring inflation to the target level within a reasonable horizon.

The MPC is the key body in the setting of the interest rates. It composes of seven members chaired by the Governor; five BoG officials and two external members appointed by the Minister of Finance and Economic Planning.

The BoG communicates with the public about the interest rate, and accounts to the government through Parliament and the Ministry of Finance and Economic Planning. Although the Bank is not obliged by law to account to the government, the governor can be

summoned by parliament to account for monetary policy conducts of the Bank. (Bank of Ghana, http://www.bog.gov.gh)

2.3 Theoretical Literature Review

This section presents the theoretical models of inflation and its dynamic relationships with other macroeconomic variables. Some of the theoretical backgrounds present the basis and rationale for the inflation targeting monetary policy framework.

2.3.1 Inflation and Output Relationship

The theoretical relationships of output and inflation are imbedded in the theories of aggregated demand and supply. The interaction of the aggregate demand and supply both in the short run and long run affects inflation and inflation expectations.The interactions of the AD, AS and LSA curves determines the current level of inflation. These interactions are shown in the figure below.

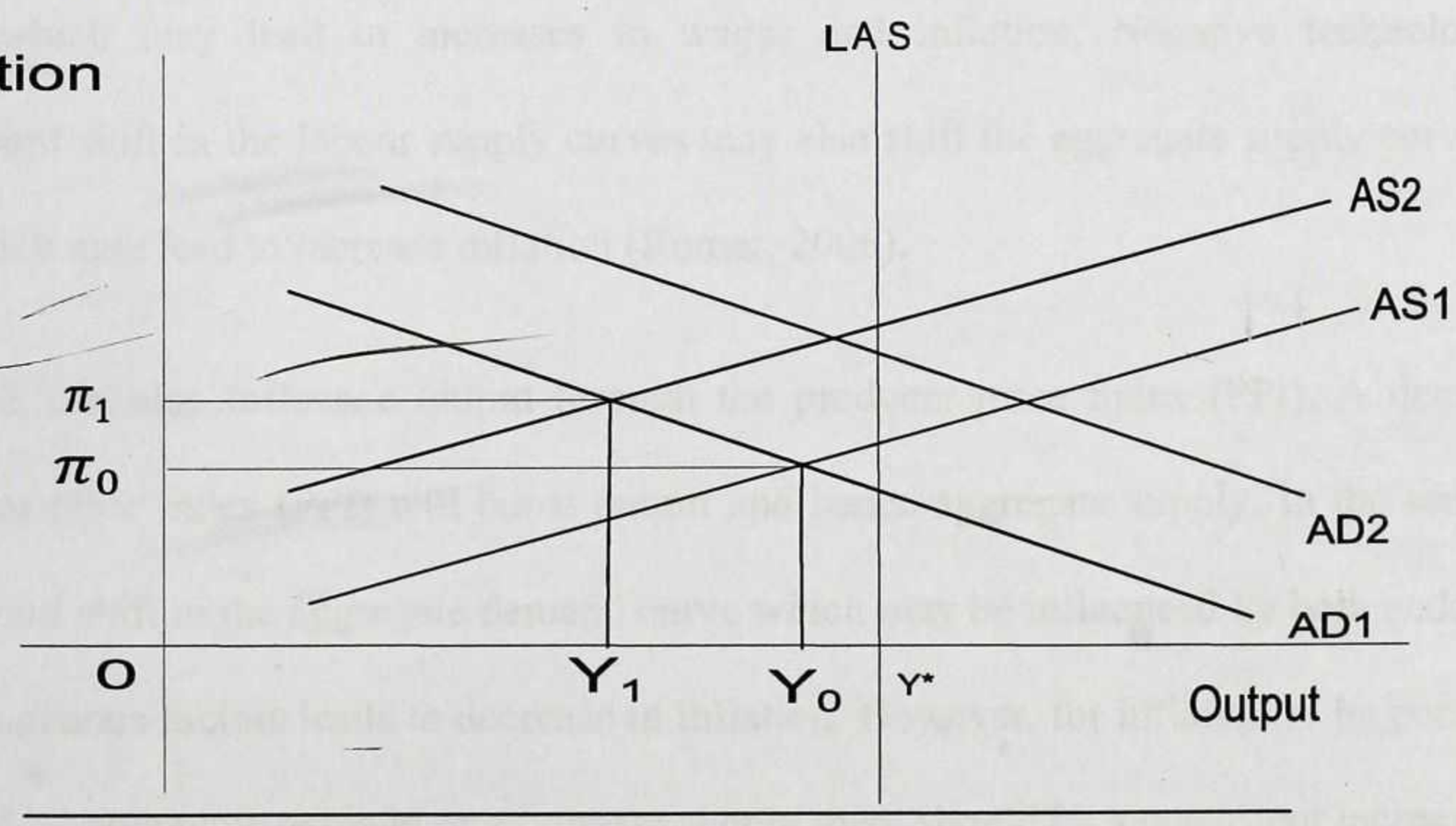

Fig. 2.1 The interaction of the AD and AS cuves , output and inflation

From fig. 2.5, at the point of intersection of the AD1 and AS1, the level of output is Y_0 and the rate of inflation is π_0. If the AD1 curve shifts to point AD2, both inflation and output increases, but output increase more than inflation. When the AD curves shift downwards both inflation and output decreases but output decreases more. If the AS1 curve move to point AS2, the inflation rate increases, and output reduces to Y_1.

An upward shift of the AD curve from AD1 to AD2 increases the level of inflation as well as the level of output. The upward shift in the AD curve could be caused by the growth rate of money which decreases the interest rate and hence stimulate investment. The positions of the curves depend on the level of lags of output. High lag-output goes with high AD curve. Even though change in the growth rate of money shifts the AD curve by the same amount (decrease or increase), both output and inflation rise but inflation rises less than output which means that the increase in money could lead to increase in output with less inflationary pressures in the short term.

Shift in the aggregate supply curve also influence the rate of inflation and levels of output. When the AS curve shifts upward, the inflation rate increases and the level of output reduces. Factors such as increase in expected inflation rate can cause an upward shift of the supply curve which may lead to increases in wages and inflation. Negative technology and downward shift in the labour supply curves may also shift the aggregate supply curve to the left which may lead to increase inflation (Romer, 2006).

Inflation can also influence output through the producer price index (PPI). A decrease in producer price index (PPI) will boost output and hence aggregate supply. In the same way, downward shift in the aggregate demand curve which may be influenced by both endogenous and exogenous factors leads to decrease in inflation. However, for inflation to be persistently reduced by aggregate demand or aggregate supply there should be a consistent increase in the

AS or consistent decrease in AD. Consistent increase in AS cannot be possible due to technology shocks. Factors such as government expenditure that can induce consistent decrease in AD are also limited in scope. This means that a consistent increase in AS or a consistent decrease in AD is most unlikely over the long term. In the long run, therefore, money is the only factor that can have lasting effects on inflation. However, favourable macroeconomic fundamentals can be conducive for sustained decrease in inflation. Significant and sustained disinflation can in turn influence GDP growth over the long term.

In the long run, the economy could be at the steady state which means the factors which influence movement of the AD and AS curves- the growth rate of money, inflation expectation, output and inflation- have the tendency to be constant producing a steady state growth rate of inflation and output; $\pi = \pi^e$ and $Y_t = Y^*$.

At the steady state, therefore, the inflation rate is determined solely by the growth rate of money. The Friedman hypothesis holds- inflation anywhere and everywhere becomes a monetary phenomenon. Growth rate of money leads to high inflation rate. In that case, the inflation rate is equal to the growth rate of money, $M_0 = \pi_0$. The steady state analysis is shown in figure 2.2.

If money supply increases, aggregate demand increases, but since the economy is at full employment level, aggregate supply cannot be increased to satisfy the increment in aggregate demand. This will then lead to pressures on wages and prices which eventually reduce the aggregate supply, thereby sending the economy to higher inflation levels. In fig. 2.6, at point 1, the economy is at full employment level of output, Y*, where AS1 and AD1 intersect. If the money supply increases, it leads to increase in aggregate demand which moves the AD curve to the right from AD1 to AD2. But since the economy is at the steady state, the short run aggregate supply will have to decrease to AS2, moving back to the equilibrium level at

point 3. However, for the economy to return to this level at point 3, prices must rise from P_1 to P_2. This process continues as the money supply continues to expand, prices will continue to rise as well, and the inflation rate will continue to increases.

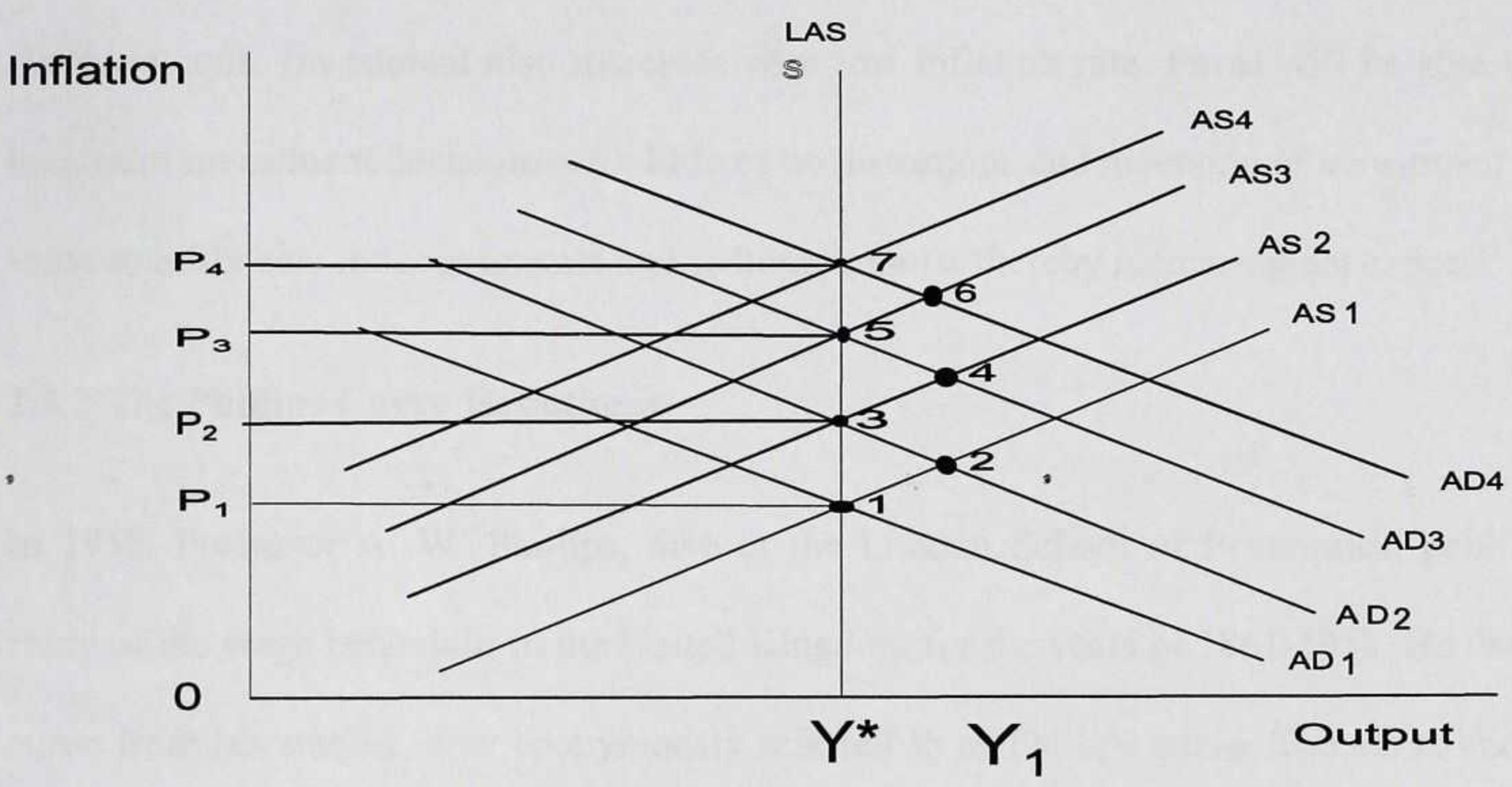

Fig. 2.2: inflation, output and the interaction of the LAS, AS and AD cuves

Keynesian macroeconomist emphasized two ways of achieving growth in output. First aggregate demand should be stimulated in order to achieve full employment. The emphasis is on achieving full employment and be able to sustain it. The focus is also on investment as a vehicle to stimulate growth in productivity. Full employment can then lead to achieving a high rate of growth.

Second, money wages affect the rate of inflation, and to keep inflation down, money wages should not increase faster than the average growth rate of labour productivity in the economy. In this way, prices will not increase, assuming prices are set as mark-up on labour cost. In the same way, rapid increase in investment can also reduce inflation rate as productivity increase.

Inflation rate have significant influence on each of the components of output/income; consumption, investment, government expenditure and net exports. Price stability influences the consumption of both durable and non-durable goods at both the household and firm levels. Low inflation rate leads to immediate increase in consumption of non durable goods, and low inflationary expectation also increases future consumption of both durable and non durable goods. Investment also increases with low inflation rate. Firms will be able to take long term investment decisions with little or no distortions and diversion of investment funds. Price stability also induces exports and reduces imports thereby increasing net exports.

2.3.2 The Phillips Curve Hypothesis

In 1958, Professor A. W. Phillips, then at the London School of Economics, published a study of the wage behaviour in the United Kingdom for the years of 1861-1958. He derived a curve from his studies, now eponymously referred to as Phillips curve. The curve showed a negative relationship between the rate of unemployment and increase in the money wages (wage inflation); a tradeoff between inflation and unemployment.

If W_t is the current wage rate, W_{t-1} is the previous wage rate, then growth rate of wage inflation can be expressed as

$$g_w = \frac{W_t - W_{t-1}}{W_{t-1}}$$

If u^* represents the natural rate of unemployment, the curve can be written as

$$g_w = -\vartheta\,(u - u^*)$$

Where ϑ measure the degree of responsiveness of wages to unemployment. When wage/prices are falling, then unemployment exceeds the natural rate ($u > u^*$). When wages are rising, then unemployment is below the natural rate, ($u < u^*$).

The Phillips curve shows that wages and prices adjust relatively leading to changes in aggregated demand. If the economy is in equilibrium, prices are stable and unemployment is at its natural rate; and there is a percentage increase in the money stock, then prices and wages will have to increase at the same proportion for the economy to return to equilibrium. However, the Philips curve shows that for wages to increase by the same percentage, unemployment must fall. This will cause the rate of increment in wage rate. Wages will rise, prices will rise, and the economy will eventually return to full employment level of output. In the meantime, the increment in money stock would have caused a decrease in unemployment.

The relationship of current and previous wages can be shown by the rate of wage inflation;

$$W_t = W_{t-1}[1 - \vartheta\,(u - u^*)]$$

This means for wages to rise, the previous level of unemployment will have to fall below the natural rate.

The Philips curve is now been used generally to describe the tradeoff of inflation and unemployment. Thus, the relationship between changes in the output gap and the inflation rate is known as the Philips curve. In theoretical sense, the Phillips curve is linear or convex. In the convex form, it means that there is positive deviation of aggregate output from potential output.

The capacity constrain theory also posits that firms may not be able to adjust their capacity beyond certain levels, particularly in the short run. Thus when aggregate demand increases, the effects of inflation will tend to be greater than during period of low inflation. This can make the Phillips curve to assume convexity. Convexity of the curve may also arise from the perspective of the traditional Keynesian assumptions that nominal wages are sticky

downwards and flexible upwards which can give the rise to a quasi-convex aggregate supply schedule. The Phillips curve is shown in figure 2.3.

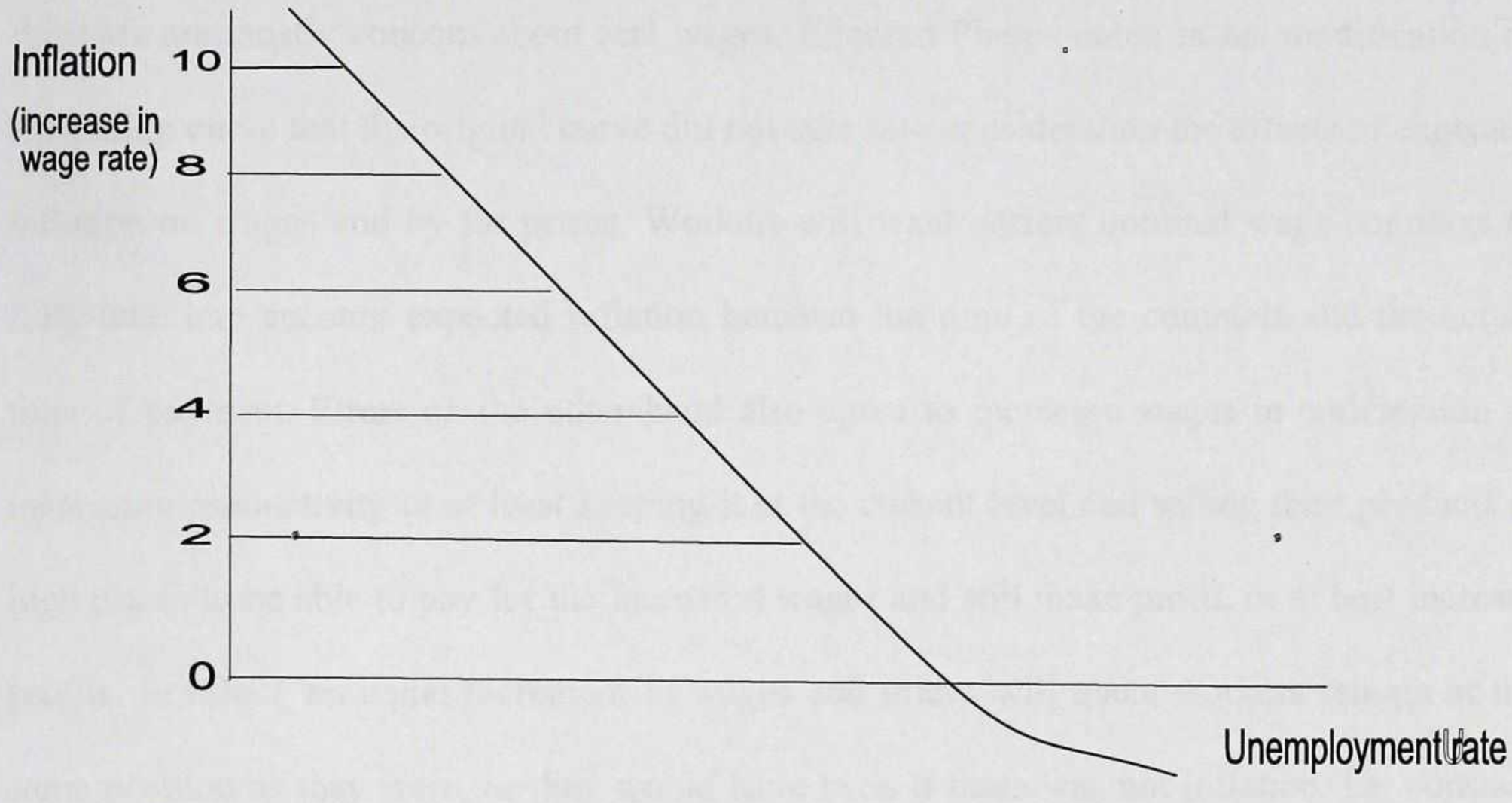

Fig. 2.3: The Phillips cuve

The AS curve can be expressed to capture ongoing inflation (continuous increases in the inflation rates). From the aggregate supply side, the curve can be transformed to represent the relationship between output and inflation as below;

$$p_t = p_{t-1}[1 + \delta(y_t - y_t^*)]$$

Where p_t represents the level of price, y_t is output and y_t^* is the full employment level of output. The inflation rate can then be defined as;

$$\pi = \frac{p_t - p_{t-1}}{p_t}$$

Combining the two equations gives;

$$\pi = \delta(y_t - y_t^*)]$$

This equation shows that the inflation rate is high when output exceeds the full employment level. Output is high when unemployment is lower.

Workers are mostly concern about real wages. Edmund Phelps noted in his modification of the Phillip curve that the original curve did not take into consideration the effects of expected inflation on wages and by far prices. Workers will want current nominal wage contracts to fully take into account expected inflation between the time of the contracts and the actual time of payment. Firms on the other hand also agree to increases wages in anticipation of increasing productivity or at least keeping it at the current level and selling their products at high prices to be able to pay for the increased wages and still make profit, or at best increase profits. In effect, an equal increment in wages and prices will make workers remain at the same position as they were, or they would have been if there was not inflation, i.e. constant wages.

The Phelps modification argues that increase in wages compensates for expected inflation, or wages can also be adjusted for past inflation which means there is compensation for lag inflation rate. In this case, inflation adjustment is for wages and prices increments either for forward looking expectation or compensation for past inflation.

The augmented Phillips curve with expected inflation can then be presented as;

$$\pi = \pi^e + \delta(y_t - y^e)$$

In this equation, the actual inflation is determined by both the expected inflation and output gap. Expected inflation reflects in wages which pass onto prices. High expectation of inflation can therefore account for high inflation rate even if unemployment is high.

2.3.3 The Nexus of Inflation, Exchange Rate and Interest Rate

Over the past decade, understanding the dynamic interrelationships of exchange rate, inflation rate and interest rate have become important for policy makers. Researchers on the dynamic interconnections among these variables have not been conclusive and specific. Little consensus has emerged in empirical and theoretical studies about how exchange rate, inflation rate, and interest rate are causally linked and how their dynamic interrelationship affect common macroeconomic targets, such as inflation itself and growth.

The diagram below presents the basic framework of the nexus of inflation rate, interest rate and exchange rate.

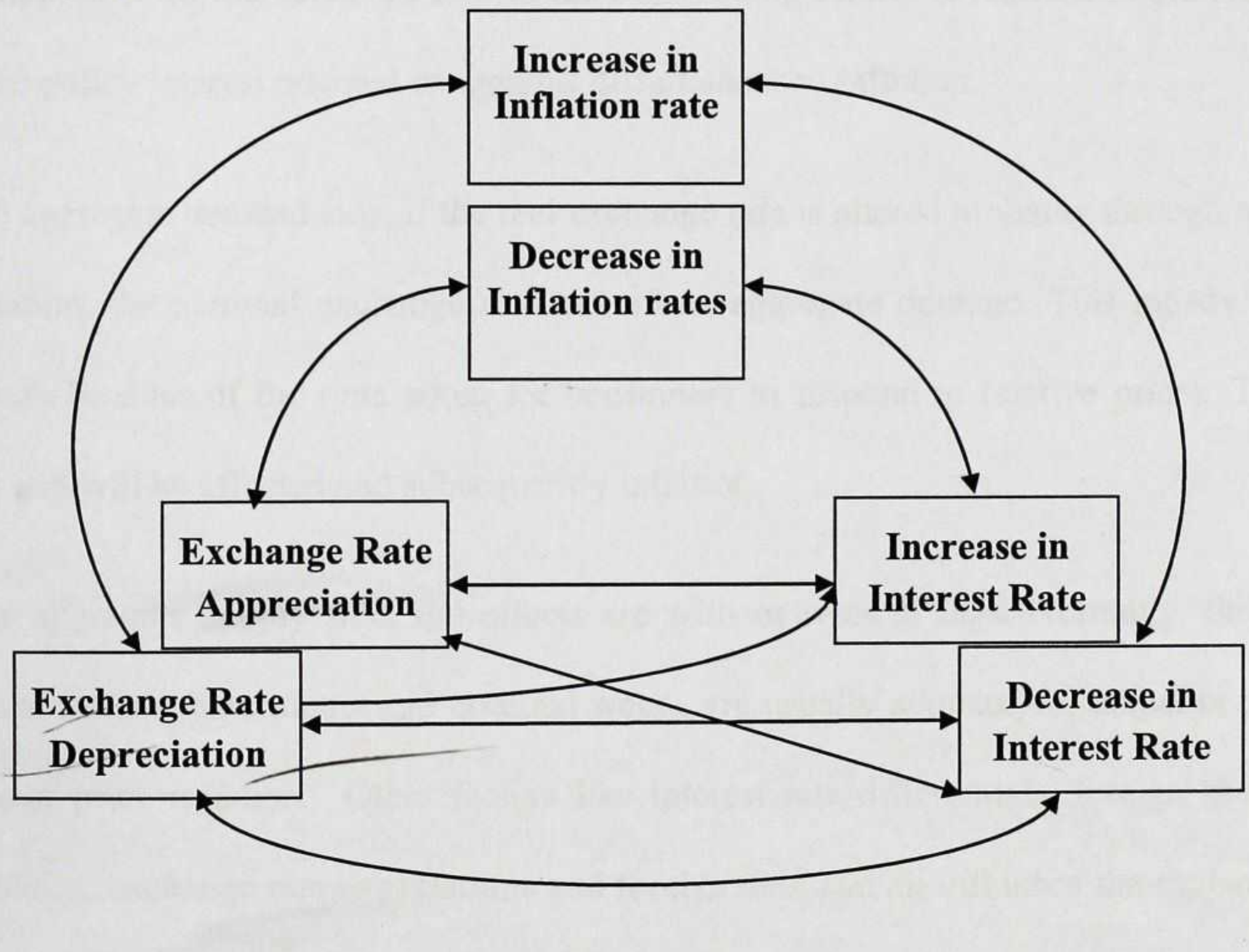

Fig. 2.4: The nexus of inflation, interest rate and exchange rate.

From the diagram, increase in inflation can lead to exchange rate depreciation. By the purchasing power parity (PPP) theorem, increase in inflation makes the domestic currency relatively weaker in terms of its trading partners. Depreciation in the domestic currency can lead to increase in the interest rate on foreign transactions, especially on loans calibrated in foreign currencies leading to what Calvo and Mishkin (2002) called liability dollarization. This can have a pass-through effect to domestic interest rate especially in a small highly integrated opened dollarized economy.

The exchange rate plays significant role in the transmission effects of monetary policy. The exchange rate affects both inflation and output in the transmission process. Apart from the direct channel via the effect of the prices of imported good on domestic prices, there can also be channels of pass-through to inflation through aggregated demand and aggregate supply. The importance of the exchange rate in the transmitting effects is realized in the changes of both the policy interest rate and exogenous disturbances to inflation.

On the aggregate demand side, if the real exchange rate is altered probably through reduction in inflation, the nominal exchange rate can affect aggregate demand. This mostly happens with lags because of the time taken for consumers to respond to relative prices. Thus, the output gap will be affected and subsequently inflation.

On the aggregate supply side, the effects are with or without lags. Normally, the cost of imported intermediate inputs and nominal wages are usually adjusted for actual or expected consumer price inflation. Other factors like interest rate differentials, foreign shocks and disturbance, exchange rate expectations and foreign debt can all influence the exchange rate. The exchange rate movement then affects inflation and inflation expectations and thus the aggregate supply.

The interactions between the exchange rate and interest rate affect the economy variously. They affect inflation, net export and overall economic activities. Theoretically, the uncovered interest rate parity hypothesis posits the interest rate differentials between two countries to correspond to the anticipated changes in the exchange rate during the period under consideration. Accordingly, high interest rate is linked with expected depreciation of the currency. If the interest rate is high as in the rest of world, uncovered interest rate parity hypothesis says that the anticipated future exchange rate will be the same as current exchange rate. Unexpected increase in the interest rate will then lead to capital inflow which will lead to future depreciation of the currency. High exchange rate should therefore lead to lower interest rate and vice versa, all other things being equal.

The prices of imported commodities are partly influenced by exchange rate. If the horizon of depreciation is anticipated in the short term, the pass-through to prices might not be significant. However, in a situation where firms and households expect continuous depreciation, domestic prices may be affected. In cases where the pass-through is non-linear, there may not be significant effect on domestic prices even if changes in the exchange rate are very significant as in the case of large depreciations.

Increase in inflation can also have direct effects on nominal interest rate. Thus financial institutions may have to adjust their market rates in other to prevent losses on loans and other financial instruments. This can also have a pass-through to exchange rate. High domestic interest rate may induce capital inflows leading to appreciations in the domestic currency. However, high nominal but low real interest rate can also lead to capital outflows leading to exchange rate depreciations. By the opposite effects of the PPP theorem, a decrease in inflation can lead to appreciation in the domestic currency.

The relationship between inflation and interest rate can be depicted by the Fisher equation.

The interest rate equations is,

$$r = i - \pi^e$$

Where r is the real interest rate, i is the nominal interest rate, and π^e is the expected inflation.

The real interest rate is the difference between the nominal interest rate and expected inflation.

The Fisher equation shows that inflation affects the real interest rate one-for-one. The growth in inflation could result from growth in money supply; or in the short term, from government expenditure. Wherever the source, sustained rise in inflation leading to rise in expected inflation will increase the interest rate. In the same vein, a sustained decline in inflation which reduces expected inflation will also lower the nominal interest rate.

By the Fisher effect, inflation expectation can also affect the term structure of the interest rate. The term structure of the interest rate is the relationship among interest rates under different horizons. By the expectation theory of the term structure hypothesis, rational expectation can influence the term structure of the interest rate. With no uncertainty, short terms interest rate, on the average, will relate with the long term rate. This will make the long term interest rate to follow the path of the short term interest rate. However, with uncertainty, future or long-term path of the interest rate rather influences the short-term rate due to inflation expectation.

Closely related to the Fisher identity on the relationship of inflation and interest rate is the Taylor interest rate rule. The basic Taylor (1993) interest rates rule proposes for the nominal interest to rise more than one-for-one with inflation rate. It also proposes for the interest rate

to fall when output is below the full employment and rise when output is above that. The basic Taylor rule can be presented as;

$$i - \pi^e = \alpha + \beta_\pi \pi + \beta_y (y - y^e)$$

i is the long term nominal interest rate, π is inflation rate, π^e inflation target, y is actual output growth rate, and y^e is potential output growth rate. From the equation, the real interest rate will have to increase above its long run equilibrium level in response to inflation exceeding its target and to output exceeding its natural rate.

As noted earlier, the Taylor rule provides the theoretical basis for the interest rate rule of central banks for inflation forecasting and targeting. The interest rate rule of a central bank depends on whether it practices strict or flexible inflation targeting. Flexibility entails a tradeoff between inflation variability and output variability. The rule also determines the central bank's loss function. A simple loss function can be expressed as;

$$L = (\pi - \pi^e) + \theta (y - y^e)$$

$\boldsymbol{\theta}$ measures the relative weight the central bank places on output variability and inflation variability. By varying the central bank relative weight on the two policy goals in the loss function, the central bank chooses the set of combination of inflation variability and output variability that is attainable for policy makers. The larger the increase in output variability that accompanies the reduction in inflation variability, and the higher the relative weight attached to output fluctuations in the loss function, the longer it will take for the inflation rate to converge to its target following a shock. A sustained rise in the price levels will lead to rise in expected and nominal interest rate.

If price are sticky, a decrease in interest rate may stimulate growth in output if the degree of decrease in real interest rate are so large to offset the effect of increase in expected inflation.

The real interest rate can eventually normalize if prices are flexible. This could therefore lead to increase in the nominal interest rate in the long run despite the decrease in the short run which was resulting from the domination of the real rate effects on expected inflation in the short run.

It is important to note that there are other several individual factors which influence these variables either, individually, two of them, or collectively at any point in time. For instance, the exchange rates respond heterogeneously to interest rate innovations in several developing economies. The responses depend on several factors which include the size of the interest rate increases and the initial level of the interest rate. Nevertheless this framework presents some basic linkages. A disturbance in any, two of them or all of them collectively can therefore have a ripple effect.

2.3.4 Alternative Concepts to Inflation Targeting

Monetary Targeting

The role of nominal anchor in the conduct of monetary policy has been increasingly recognized by economist over the years. A nominal anchor acts as a stabilizer or a check on monetary policy. It refers to a nominal variable that policy maker use to tie the price level such as inflation, exchange rate and money supply. Nominal anchor acts as an instrument of stability by keeping nominal variables in their reasonable or acceptable ranges to support macroeconomic stability and reduce inflationary expectations. Reduction in expectation also helps cement stability by lowering volatility of inflation.

The gradual unpopularity and rejection of the ideas of expansionary monetary policy for high output, the cost of inflation, and recognition of significant role of monetary policy led to the

birth of monetary targeting in most industrial countries in the mid 1970s. Mishkin (2006b) identified three element of monetary targeting: "1) the reliance on information conveyed by a monetary aggregate to conduct monetary policy; 2) the announcement of medium-term targets for monetary aggregates; and 3) some accountability mechanism to preclude large and systematic deviations from the monetary targets."

Monetary targeting has some advantages. Monetary policy actions are reported relatively very quickly which can send immediate signals to the public and the markets about the decisions of monetary authorities and the measures taken to keep inflation under control. This has possible effects on reduction in inflation expectations. Monetary targeting also has an accountability framework that explains deviations from targets.

These advantages of monetary targeting are however dependant on how viable and sustainable the policy is in the first place. Monetary targeting depends on strong, reliable and stable relationship between the policy goal variable and targeted aggregates. If the relationship is not stable due to large swings in volatility or variability in the policy and/or goal variable(s) which renders the relationship weak, monetary targeting will simply not work, it will not be effective in influencing macroeconomic performance.

The breakdown in the relationship in the goal variables such inflation and nominal income and monetary aggregates was common place in the US, Germany and other nations who adopted the policy, and more especially in the developing and emerging market economies. This was as a result of high instability in the macroeconomic environment and the overly exploitation of the perceive relationships for monetary targeting conducts. These developments made monetary targeting unsuccessful in most countries in terms of its effects on macroeconomic stability and growth and hence most countries chose to abandon it.

Price Level Targeting

Price level targeting is very unpopular and very closely related to inflation targeting. Price stability is the ultimate goal of any inflation targeting regime. However, countries have an inflation target rather than price level target. Monetary authorities normally target a level of inflation that is consistent with price stability. Allan Greenspan (2001) provided a widely acclaimed definition of price stability. He defined price stability as "when economic agents no longer take account of the prospective change in the general price level in their decision making process." This means the level of inflation rate that is sufficiently low that economic agents are comfortable enough to make long term decisions without worrying about possible effects of inflation.

Mishkin (2000) identified two advantages of price level targets: 1) it reduces long term uncertainties which make long term planning and economic decisions less complicated for economic agents; and 2) it may cause less output volatilities as compared to targeting of inflation rate, but this assertion is supported by model specific on key assumptions of the price setting process and the degree of its forward looking.

Mishkin, however, also identified some disadvantages of price level targets; 1) price level targets can lead to greater output variability. This is because the shocks to the target price level must be immediately offset which could result in greater variability in the economy in the short run. 2) Price level target could lead to deflation which may cause financial instability. This could lead to increase in net debts of economic agents which may lead to reduction in wealth accumulation, investment and consumption. Net reduction in wealth could then lead to adverse selection and moral hazards on the part of borrowers. 3) Price level targets complicate monetary policy when interest rate hit floor of zero. This makes the interest rate channel of monetary policy less effective. If monetary policy is then base on the

Taylor rule, it will become ineffective since the short run interest rate will be the policy rate.

4) The measurement error in inflation could also lead to uncertainty if price level target is adopted.

So given all these difficulties of price level targets, and the fact that the primary goal of inflation targeting is price stability, what level of an inflation target will deliver this price stability or be consistent with it? Mishkin (2000) argues for any inflation rate between 0 to 3%. A 0% level of inflation could be very difficult to achieve but an argument for it is that it increases the central bank's credibility and greatly reduces inflation expectation. However empirical literature proves that having a target above 0% but not too far from it for a long term inflation target does not harm the central banks credibility and/or cause instability in the inflation expectation (Bernanke et al, 1999). Argument against 0% percent long term target is that inflation target at such a low level may lead to economic inefficiency which could decrease productivity and increase the rate of unemployment.

Mishkin (2000) therefore argues for setting the inflation target a little above zero to reduce the possibility of deflation and its effects. A target above zero will also send a message of flexibility in monetary policy and the central banks concerns for other real variables such as the output gap and unemployment. This could help win public support which is crucial for success of the framework.

In the light of the above arguments, Mishkin (2000) argues for inflation targeting instead of price level targeting. Inflation targeting seems less complex and likely to have the support of the public.

Exchange rate Targeting

Exchange rate targeting involves pegging a countries monetary policy to another potential low inflation country. The pegging country is mostly with high volatility in inflation and exchange rate and pegs with a country with stable inflation and exchange rate in other to stabilize these variables in the pegging country. This policy has been particularly appealing to developing and emerging market economies because of high exchange rate and inflation volatilities. Mostly, they peg to the US dollar.

Mishkin (2006b) identifies some advantages of exchange rate pegging. 1) It anchors inflation to the inflation of the anchor country thereby reducing inflation expectation in the pegging country as long as the peg is credible. 2) It reduces the inflation rate in the pegging country by tying it to the anchor county's inflation rates. 3) By tying the inflation rate of internationally traded goods to prices in that of the anchor country, exchange pegging helps stabilize the inflation rate in the pegging country. 4) Exchange rate pegging can also reduce the time inconsistency problem if there is a strong commitment to the peg. In this sense, pegging will be serving as a policy rule and then serves as a nominal anchor in the pegging country. 5) Exchange rate targeting offers the path for policy reaction to depreciation by contracting monetary policy, or by adopting expansionary policy in the case of excessive appreciation. Exchange rate pegging is also very appealing as a monetary policy option for developing and emerging market economies who so much desire stability for regional integration and monetary unions like the "converging criteria" for the "eco" currency in West Africa. But this can be very difficult to achieve in an environment of weak fiscal, financial and monetary institutions.

There are however some disadvantages with pegging as well: 1) the pegging country may lose monetary policy independence. With capital mobility, the central bank in the pegging

country may be incapable of formulating independent monetary policy to deal with domestic shocks that are independent of those hitting the anchor country and this could have serious effects on the pegging country currency and stability in the financial sector. 2) Shocks to interest rate in the anchor country can pass through to the targeting country. 3) Exchange rate pegs can weaken accountability of the central bank especially in developing and emerging market economies. 4) Pegging can unduly constraint expansionary monetary policy because of fear of depreciation of the domestic currency even in times when expansionary policy could be the best option out. 5) Exchange rate pegs can also open the pegging country to speculative attacks. In case of successful attacks, the country can experience severe and rapid unexpected depreciation in the currency especially under floating exchange rate regimes. This could cause severe contraction in economic performance in developing and emerging market economies because of liability dollarization coupled with the weak fiscal, financial and monetary institutions.

With the above weaknesses of exchange rate pegging it becomes relatively difficult for developing and emerging market economies to be fully committed to the peg especial in the wake of financial and economic crises

2.4 Empirical Literature Review

This section presents the empirical literature review of the inflation targeting framework. The section is sub-divided into empirical literature of inflation targeting in developing and emerging market economies, and a general empirical literature.

2.4.1 Empirical Studies on Inflation Targeting

A lot of empirical studies have been done on the performance of the framework with varied methodological frameworks. This section presents, in a chronological order, some of the empirical studies on inflation targeting.

Lamonchi (2013) studied the possible effect of inflation targeting on real exchange rate volatility and whether this varies according to announced and practice exchanged rate regimes using a panel data of 62 countries within the period of 1987-2011. The sample included 32 developing countries (14 targeting and 18 non-targeting countries) and 30 developed countries (13 targeting countries and 17 non- targeting countries). They found that the adoption of inflation targeting increased the volatility of real interest rate as one of the cost. The exchange rate volatility varied across developed and developing nations regardless of the regime. In developed countries, adoption of the framework generally increased the average rate of exchange rate volatility which is high for targeting countries than non-targeting countries. In developing countries, the volatility is not significant. There is also no difference in volatility across targeting and non-targeting countries or pre and post adoption periods of inflation targeting in developing countries.

The total sample analysis evidence showed that the adoption of inflation targeting increased exchange rate volatility; a negative relationship between the framework and volatility in real

exchange rate. On the classification of the de jure and de facto exchange rate regimes, the study found the effect to depend considerably on the type of exchange rate regime. The fixed regime under de jure in developing countries has the effects on real exchange rate which tend to increase volatility. Under the de facto, the results showed that flexible regimes with inflation targeting tend to have an increasing effect on volatility of the exchange rate. For developed countries under the de jure, inflation targeting combined with flexible regime policy mix has effects on increasing average volatility in exchange rate. Under the de factor, the combinations of inflation targeting and exchange rate regimes have impact on volatility of exchange rate.

Bha and Mallik (2012) studied the quarterly data of inflation, inflation uncertainty and macroeconomic performance in Australia. They found that inflation uncertainty have significant negative effects on inflation and growth in output at least after adoption. Output uncertainty also has significant negative effect on inflation. Using oil prices as dummy and control variable, the study found output to significantly increase inflation uncertainty.

Cho and Rhee (2012) employed the monetary business accounting approach developed by Sustek (2011) to examine the effectiveness of the inflation targeting framework in stabilising the real economy of the advanced economies. They found that advanced economies such Canada, Australia, UK, and Sweden who adopted the framework in the early 1990s were successful in stabilizing business cycle fluctuations.

Chu and Sek (2012) applied OLS and panel data analysis to evaluate the performance of inflation targeting in developed and developing nations. They compared the performance of pre and post inflation targeting periods in developed and developing nations base on inflation persistence, output growth, exchange rate volatility, deviations of inflation and the output gap and as well tested for the tradeoff between inflation and output. The developed nations

included Spain, Korea, UK, Sweden and Finland whilst the developing nations included South Africa, Brazil, Columbia, Philippines, Poland and Thailand. They found that inflation targeting has contributed to overall performance in developing nations. Reduction in inflation was not found to be associated with high volatility of exchange rates. Developing economies experienced larger reduction in inflation but developed nation gained more in terms of growth. There was evidence of volatility in the exchange rate but no evidence for tradeoff between inflation and output gap which could not be explicitly attributed to inflation targeting because tradeoffs were experience even in the pre-inflation targeting period. Deviations in inflation also increased in the post inflation targeting period in developing economies.

Fouejieu (2012) investigated whether countries who adopted the inflation targeting were able to cope with the global financial crisis of 2008 than non-targeters. Applying difference in difference (Ball and Sheridan, 2005), he found no significance difference in terms of inflation and outputs growth. However, the rise in inflation and interest rate during the period of the crises was significantly less pronounced for targeters.

Brito (2011) revaluated the treatment effects of inflation targeting in industrial economies that adopted the regime in the early 1990s. His results showed that inflation targeting has significant effect on realized inflation and GDP. With dynamic panel regression model that controlled for observable and non-observable co-variances, the study found evidence that inflation targeting does really matter for pioneering industrial targeters. The framework caused no decrease in output or increase volatility in inflation and output.

Carrusco and Ferreiro (2011) studied a monthly data of inflation of 1993.0-2009.0 to analyze the impact of inflation targeting on macroeconomic performance in Mexico in terms of variability of inflation and output. They concluded that inflation targeting has helped in

locking in the gains of disinflation and lowering inflation expectation, but disinflation cannot be evidently said to be the direct result of the framework. They attributed disinflation to other factors such as the Baxico reforms in Mexico and not the framework per se. Both inflation levels and volatility had begun falling before the adoption of the framework. The study did not however find significant growth in GDP, but concluded that inflation targeting has improved the performance of the Mexican economy.

Kun (2011) evaluated the performance of inflation targeting in Korea, Philippines and Thailand by adopting a bivariate GARCH (1, 1) model to study the pre and post inflation targeting periods of these economies by comparing their performance across the pre and post periods using each country's specific data. In his overall analysis, inflation targeting has improved the economies of these nations. The study observed lower inflation rates in the post inflation targeting period but did not find any significant relationship between inflation and the output gap. Both the output gap and inflation appeared to be influenced by their impulses, and hence no significant tradeoff between them in all the economies after the implementation of inflation targeting. The output gap is however more persistent compared to inflation. This persistence changed in both sub fields in Korea. Philippines however experienced lower persistency in the rate of inflation after the implementation of the framework. The persistency rate of output declined in post inflation targeting period in Korea, and in Thailand the persistency rate changed in the two sub periods. Conditional variance in the output gap was positively related to its past squared errors, but the correlation declined in the post period. The correlation increased in Korea and Philippines but declined in Thailand after the implementation of the framework. He further checked the robustness of the results of the relationship of the output gap and inflation by comparing the GARCH (1, 1) to SVAR which yielded consistent results.

Abo-Zaid and Tuzemen (2010) used a cross-country data from 1980-2007 to analyse the effect of inflation targeting on the levels of volatility in inflation, GDP growth and fiscal imbalance in developed and developing countries. The study found that inflation targeting has helped in reducing inflation to stable levels and high stability of growth in output in developing countries. In developed countries, the study found evidence of high growth in GDP and high discipline in fiscal conduct after the adoption of the framework. In effect, the inflation targeting regime has positive impact on both developed and developing nations.

Hove et al (2010) revaluated and compared the response of different monetary regimes to shocks in order to find out whether inflation targeting does well in terms of response to commodity terms of trade. The study adopted a panel VAR analysis and showed that the inflation targeting framework contributed generally to respond better to shocks especially to inflation than other countries with different monetary regimes. They also found short run tradeoff of inflation and output but this disappears in the long run.

Petreski (2010) empirically examined the effects of regime switch from exchange rate targeting to inflation targeting and whether a switch to inflation targeting with a managed float presents an improvement in monetary policy in developing countries. Using the Taylor interest rate rule for a group of countries with historical experience of policy switch and analyzing with a switching regression and Markov switching method, he found that inflation targeting presents a real switch in developing countries which is characterised by independent monetary policy, improved stable macroeconomic environment, and a strict focus on inflation.

Salem (2010) assessed the conditions for adoption of the inflation targeting framework in Pakistan with the VAR approach and argued for adoption of inflation targeting to achieve

price stability in Pakistan. She argued that inflation is adaptive in nature as people are forward looking in forming expectation about inflation.

Taguchi and Sohn (2010) assessed the performance of inflation targeting and the pass-through rate of external price shocks to consumer price inflation in Korea, Indonesia, Thailand and Philippines from period of 1990 to 2009. They found Korea to have taken a forward looking response toward inflation whilst Indonesia and Thailand adopted a backward looking rule. Only Korea has lost the pass-through under inflation targeting which shows a clear linkage between inflation response rules and the loss of the pass-through. The study concluded that a forward looking inflation targeting can resist external shocks.

Vasilescu and Mungiu-Pupăzan (2010) analyzed the generality of the inflation targeting framework and its effects on macroeconomic performance. A comparative study of the pre and post adoption of inflation targeting showed an improvement in the economic conditions such as technical infrastructure, financial system efficiency and institutional independence. They also found targeting countries to only meet the so-called precondition of the framework partially at the time of adoption. Industrial countries significantly performed better in this regard relative to emerging market economies. They suggested that the preconditions for adoption cannot be obstacle for actual adoption.

Alichi et al (2009) applied a model for full-fledged inflation targeting to Ghana, and reached the following conclusions: 1) monetary policy in Ghana as in many emerging market economies faces difficulties of creditability, the hesitance of the central bank to raise short term interest rate in aversion of sharp contraction of the output gap, vulnerability of the economy to external shocks, and continues structural changes in the economy. 2) The inflation targeting framework offers solution to these challenges as continues pursuance of inflation eventually earns credibility. Flexibility in short run interest rate allows the central

bank to moderate interest rate and the output movements; and the policy loss functions also allow policy makers the aversion of the output gap and interest variability. 3) The optimal path of disinflation in Ghana is more rapid with less short run loss of output and greater credibility which will, however, entail raising interest rate to a level that could dampen demand and brings about visible disinflation. 4) The demand shocks caused by the implementation of inflation targeting can easily be managed because monetary instruments act through demand channels; but this will require a mixed of fiscal discipline to sustain. 5) Adverse supply shocks after the adoption of inflation targeting poses serious challenge to monetary policy; a favourable shock will aid disinflation with minimum output losses and smaller increase in interest rates. However the impact of adverse shocks can be severe and long lasting as a result of inflation expectations.

Fang and Miller (2009) evaluated the long and short term effects of inflation targeting and its relevance in industrial countries from 1985 to 2007. The countries included Australia, Canada, Iceland, New Zealand, Norway, Sweden, Switzerland and the United Kingdom. They argued for the irrelevance of the macroeconomic effect of inflation targeting due to the time varying factors in monetary policy performance. Targeting countries achieved lower inflation immediately after adoption. Targeters also experienced temporary slower output growth and higher inflation and output growth variability. However, these effects are for the short term, and disappear in the long run. They concluded that the framework significantly reduced inflation at lower cost in the short run in terms of growth and variability in output and high inflation variability, but had no substantial effect in the medium to long term. Treatment effects of inflation targeting on inflation were significantly positive in the year of adoption of the framework. The effect reversed significantly to negative after the first year of adoption. Both inflation and output variability were significantly high, two years after

adoption. There was, thus, an intertemporal trade-off of inflation targeting in the eight industrial countries.

Garcia-Solanes and Torregón-Flores (2009) analyzed the extent to which inflation targeting has improved macroeconomic performance in a group of Latin American countries. The countries included Brazil, Peru, Chile, Colombia, and Mexico, and the study focused on the inflation rates, the short term variations in exchange rates and foreign reserves, and GDP growth. They concluded that the countries performed better both in the short and long run. GDP growth has increased and this is supported by flexible exchange rates.

Sanchez (2009) attempted to characterised inflation targeting regime in South Korea by estimating an objective function. He concluded that the inflation targeting regime in Korea could be characterised by optimal monetary policy aimed at achieving price stability with considerable smoothening. The monetary policy setting is also estimated to place less weight on output and exchange rate volatility.

Barbosa-Filho (2008) studied the Brazilian experience with the inflation targeting framework. The results suggested that the framework has been helpful for disinflation after the Brazilian currency crisis of 1999 and 2002. There had also been a significant appreciation of the exchange rate and increase in growth rate though the growth rate was slower under the framework than under exchange rate targeting. The framework also reduced the volatility of exchange rate than under the exchange rate targeting regime. There had also been reduction in the rate of interest. The study concluded that the framework is an improvement in monetary policy in Brazil relative to the previous regime, and recommended that inflation targeting can be combined with dirty floating regime so as for the government to accumulate foreign reserves and reduce dependence on capital inflow.

Bjørnland (2007) explored series of univariate and multivariate approaches of extracting the output gap in Norway and compared the value added in forecasting inflation. He found that models including the output gap performed better in predictive and better in forecasting inflation than models base on alternative indicators. They also found multivariate measures of the output gap to perform better than univariate measures.

Capistárn and Ramos- Francia (2007) investigated the effect of inflation targeting on inflation expectation using 16 years monthly panel data of twenty six countries which included fourteen targeting countries. After controlling for exogenous factors such as global disinflation, individual country dynamics, and time specifics, they found lower dispersion of long run inflation expectation for inflation targeting countries than non-targeters. The results further found this effect to be present in developing counties than in developed countries. They suggested that this could enhance, or in some developing nations, introduce the expectation channel of monetary policy transmission. The results seem to support the popular view that inflation targeting performs better in terms of disinflation in countries with previously poor inflation performance.

Batini and Laxton (2006) studied the effect of inflation targeting on macroeconomic performance and the potential cost associated with the framework by comparing the performance of 31 central banks (13 targeting countries and 22 non-targeting countries). They compared the performance of targeting and non-targeting countries and suggested that targeting countries performed better relative to other monetary regimes such as exchange rate and monetary targeting regimes. Targeting countries have been successful in anchoring inflation and inflation expectations with no adverse effects in terms of lost in output growth rate. Average inflation falls faster for both targeting and non-targeting countries but targeting countries have experienced more decrease in inflation. Targeting countries also converge to

low and stable inflation faster than non-targeting countries, but there is unclear pattern for convergence to stable growth in output. Their result also suggested that targeting countries experienced less volatility in interest rate, exchange rate and international reserves as compared to exchange rate and monetary regimes. They however found no evidence to support the necessity of the pre-requisites for inflation targeting. Most countries who adopted the framework did not have all the precondition in place but the feasibility and success of it depend on the commitment of monetary authorities to embark on suitable institutional reforms.

Edward (2006) investigated the relationship between inflation targeting and exchange rate. The study found that countries that have adopted inflation targeting have experienced a decline in the pass-through from exchange rate to inflation, which differs from CPI inflation to PPI inflation in most countries. He did not however find evidence for the effectiveness of nominal exchange rates as shock absorber. Adoption of inflation targeting did not also result in increase in either the real or nominal exchange rate volatility, except in 3 out of five countries that experienced increase in exchange rate volatility after the adoption. Nominal exchange rate flexibility tends to assist countries with chronic high but stable inflation rates.

IMF (2006) conducted a study to examine the experience of non-industrial inflation targeting countries by analyzing macroeconomic data, technical assistance reports and new surveys of central banks in selected emerging markets. The analysis included 13 emerging market targeting countries and 29 comparable emerging market non-targeting countries. The study made the following conclusion; 1) they have been general macroeconomic performance in non-industrial countries over the past two decades. 2) Inflation targeting countries on the average performed better relative to other countries with different monetary regimes. 3) Successful adoption of inflation targeting depends more on credible commitment than

fulfilling the technical prerequisites for adoption. A survey of the 21 targeting countries focusing on the formulation, implementation and communication of the inflation targeting framework and change in various practices of central banks during, before and after adoptions shows that all countries adopting fell short of the ideal conditions in place at the time of adoption. Quick progress towards improving the conditions is however very crucial for maximising the gains from the framework. 4) Latter prospective inflation targeters have more favourable economic and institutional environment than the current targeters at the time of their adoption. 6) Inflation targeting can be adapted to specific conditions of emerging market economies in terms of exchange rate vulnerability, rate of financial development and availability of data for successful forecasting. 7) The decision to adopt inflation targeting should be based on explicit assessment of the pros and cons of the framework compared with other alternative frameworks. Although inflation targeting has some level of flexibility, institutional and structural characteristics can complicate its suitability.

Overall, the IMF study concluded that inflation targeting has contributed to better economic performance in non industrial countries. Exchange rate and monetary targeting generate higher macroeconomic variability compared to the inflation targeting framework. The targeting countries have reduced inflation by 4.8 percentage point in average inflation relative to other regimes. Inflation targeting has also been associated with low fluctuations in inflation relative to other regimes as measured by standard deviation of 3.6 percentage points. Long run inflation expectations have been lower and more stable under inflation targeting with measures of inflation expectations of between 2.1 and 2.7 percentage lower and a standard deviation of expectation of between 2.1 and 2.7compared to other regimes. Output volatility has also been slightly lower at five percent significant level for targeting countries relative to non targeters. This suggests that inflation targeting does not come at a cost to stabilization in output.

Exchange rate volatility has also been lower under the framework than under exchange rate pegs even as compared to the most successful exchange rate pegs. Targeting countries have also been successful in dealing with shocks relative to other regimes in non-targeting countries. Inflation targeting has also lower volatility in financial markets; interest rate and international reserves have been relatively lower compared to other regimes. Inflation targeting is also associated with lower probability of crisis at 5 percent significant level relative to exchange and monetary targeting regimes. The study concluded that although the global macroeconomic environment have been positive for all countries regardless of monetary regimes, inflation targeting countries did relatively better in terms of macroeconomic performance than alternative regimes.

Apergis (2005) employed two major alternative policy rules, forward-looking and spontaneous adjustment, and three alternative inflation targets, zero percent, two percent, and four percent inflation rates to assess the merits of inflation targeting by comparing it to alternative macro targets using European aggregate data. He found forward looking rules to contribute to macro stability and increases credibility in monetary policy.

Pétursson (2005) studied the effect of inflation targeting on macroeconomic performance in targeting countries using statistical analysis and the seemingly unrelated equations estimation approach. He concluded that the framework has been success in terms of credibility, and has improved monetary policy practices in targeting countries.

Goldfajn and Minella (2004) assessed the performance of inflation targeting in emerging market economies compared to developed nations. The study showed that developing nations face more tradeoffs in terms volatility in output and inflation and higher levels of inflation than developed economies. This is attributed to the macroeconomic environment in

developing economies such as weak financial institutions and shocks. Volatility of output, inflation and exchange rate appear high in emerging market economies.

Levin et al (2004) evaluated the effect of inflation targeting on inflation expectation and inflation dynamics by comparing the time series data of five industrial targeting countries to that of seven non-targeting countries. Their results showed the effects of the framework on anchoring long run inflation and inflation expectations. They also found lower inflation persistence in targeting countries as compared to that of non targeting countries for emerging market economies. Testing for the null hypothesis of unit root to investigate inflation persistence, they concluded that the adoption of inflation targeting did not contribute to immediate fall in private sector inflation forecast, particularly at longer horizon.

Nelson-Douglas (2004) explored the applicability of inflation targeting in reducing and sustaining inflation at a single digit in Jamaica by using a VAR model to investigate issues relating to the definition of the price index and the monetary control lags. His results suggested that Jamaica will be able to implement inflation targeting over an 18-month horizon as long as the Bank of Jamaica is independent..

Hu (2003) attempted to find out which factors are systematically associated with an economy's decision to adopt the inflation targeting framework and whether the adoption of the framework improves the performance of output and inflation and induce changes in the inflation output variability under the framework. He found that inflation targeting does not improve inflation and output performance. The results of the study failed to significantly contradict the Taylor's curve.

Hováth and Matějů (2001) investigated how inflation targets are set in targeting countries. The study conducted a survey of targeting-countries and estimated the determinants of the level of inflation targets in 19 targeting-countries with unbalanced panel regression with the

presumption that the inflation targets are usually in ranges instead of points. The survey included a review of central banks and governments publications and completions of questionnaires by the monetary authorities of these nations. They found that a wide range of targets positively relate to trend of the world's inflation, and unstable macroeconomic environments. However, the inflation target is negatively related to central bank credibility which suggests that less credibility is associated with risk of anchoring inflations expectations at lower levels. Experience of high inflation and foreign inflation volatility influenced the choices of the targets. Longer horizon targets are also relatively lower as they represent the long-term optimal policy targets. This emphasised the importance of actual inflation in setting the inflation targets. High growth or degree of actual inflation is associated with high inflation target in the medium term. This lends credence to the New Keynesian Phillips curve which posits a positive relationship between output shocks and increase in inflation. It also suggests that flexible inflation targets appear more appropriate description than the strict type in the conduct of the framework.

Kadioglu et al. (2000) argued that many developing countries fail to satisfy the preconditions for inflation targeting and do not have powerful models to enable them to make successful inflation forecasts. Emerging markets are more susceptible to shocks than advanced economies and they therefore require greater flexibility in responding to these shocks. The flexibility of the framework offers distinct advantages compared to other alternatives. However, the challenge is often how to balance this flexibility with monetary policy credibility.

Bernanke et el (1999) studied VARs estimates from the period before inflation targeting, and found that inflation remained lower after adoption of the frameworks, and then remains low

once it has been reduced to a level consistent with price stability. Cyclical expansion of economic activities will have no effect in thwarting disinflation efforts of targeting countries.

Honda (1999) conducted some test on the effects of inflation targeting on macroeconomic variables in New Zealand, Canada and UK. With unrestricted VAR estimates, the study found no empirical evidence of the framework affecting macroeconomic variables. He explained that the result could be a genuine reflection of the reality of the effects of inflation targeting but could also be as a result of the fact that the number of parameters in the model were too large relative to the sample observation that the test could not reject the null hypothesis of no structural changes in macroeconomic variables.

Silkos (1998) investigated the effects of the adoption of inflation targeting on inflation performance by comparing the performance of formal adopters to non-adopters. He found that non-targeters which included US, Germany, and Switzerland had good performance despite not targeting. Mere adoption of inflation targeting is not sufficient for achieving better inflation performance or significantly influencing inflation expectations. Nevertheless, targeters such as Canada, New Zealand and UK performed well in terms lowering inflation persistence and interest rate.

From the empirical literature, inflation targeting has gone through a lot of empirical debates in it relatively short period of existence. The empirical literature has been varied from its design, implementation to the effect of the framework on macroeconomic performance. The literature generally gives the framework high marks in terms of economic performance. Inflation targeting can only undergo further modification as new economic dynamics emerge, but it has high prospects of durability.

2.4.2 Other Related Empirical Studies

This section presents a review of other related empirical studies to studies on the inflation targeting framework. The literature is base on varied issues relating to the framework in different economies. The studies are presented in a chronological order.

Boamah (2012) assessed the extent to which forward looking and backward looking Taylor type reaction functions provide a description of interest rate response to inflation rate in Ghana. Using time series estimation of simple Taylor type reaction functions to characterised monetary policy rule, he found that the Taylor rule is not a good predictor of interest rate behaviour in Ghana.

Chinaemeram and Akujuobi (2012) studied the relationship between inflation and other monetary policy instruments in Ghana and Nigeria as a precondition for the inflation targeting framework. They used series of three VARs models starting with a simple two-variable model consisting of money supply and prices, and then added the nominal exchange rate and interest rate. They found from the two-variable models that inflation is an inertia phenomenon in Ghana and Nigeria, and that money innovations are not comparatively strong and statistically important in determining inflation as price shocks themselves will do. The addition of the exchange rate and interest rate into the model did not result in any significant improvement in the model, which makes them conclude that policy linkages between inflation and monetary policy instruments are not strong in Ghana and Nigeria, and these countries are not, therefore, qualified as candidates for the inflation targeting framework.

Danjuma et al (2012) assessed the effectiveness of monetary policy in combating inflationary pressures by studying the impact of monetary policy instruments from 1980 to 2010 in Nigeria. They employed the classical least squares method with the aid of granger causality, stationarity test and corrologram. They found the liquidity ratio and the interest rates turnout

to be the leading monetary instruments that are effective in combating inflation in Nigeria. They further found that the cash reserve ratio, broad money supply and exchange rate were rendered ineffective in combating inflationary pressures by the unethical banking practices of commercial banks.

Mohanty (2012) employed the SVAR approach to investigate the interest rate channel of monetary policy transmission in India. He found that increase in the policy rate has two quarter negative lag effect on output growth and three quarters moderate lag effect on inflation, with the overall effect persisting from 8-10 quarters. The results were found to be robust with different measures of output, inflation, and liquidity across different specifications. He further found significant unidirectional causality from the policy rate to output, inflation, and liquidity with exception of M3. He argued that the findings underline the importance of interest rate as a monetary policy tool.

Nsowa and Oseni (2012) employed a cointegration multivariate vector error correlation approach to study both long run and short run nexus among monetary policy rate, inflation rate and exchange rate. They found a uni-directional causation from exchange rate and inflation rate to short term interest rate and bi-directional causation from exchange rate to inflation rate. They however found no evidence of causation from short term interest rate to exchange rate and from interest rate to inflation rate. From the VECM result, they concluded that macro variables such exchange rate and inflation Granger cause a change in monetary policy stance and not the otherwise.

Islam and Uddin (2011) studied whether interest rate can be used to keep or bring inflation closer to its target or from deviating from target. Estimating a data set of 1980-2012 with an error correlation model, they found empirical evidence that deviation of inflation from target

can be corrected through interest rate changes. They, thus, recommend the inflation targeting framework for Bangladesh.

Ncube and Ndou (2011) using the Bayesian sign restriction VAR approach derived the inflation rate equation to search for possible transmission channels between the real interest rate, inflation rate, exchange rate, and real output growth rate in South Africa. They found the real interest rate to negatively react to inflation rate shocks and that the Fisher effect holds in the long run. They further showed that the strict inflation targeting is not compatible with significant real output growth whilst flexible inflation targeting which attaches more weight to the role of real effective exchange results for significant growth in output.

De Mello and Moccero (2010) used the new Keynesian structural model which included inflation, output and interest rate to estimate policy rules for Brazil, Chile, Columbia, and Mexico under inflation targeting and floating exchange rate. They found that monetary policy has become less counter cyclical in Columbia and Mexico.

Chai-anant (2008) considered the role of the exchange rate channel of monetary policy transmission under the inflation targeting framework in Thailand. The results showed that apart from acting as a transmission mechanism under the framework, the exchange rate can also alleviate inflationary pressures under some circumstances. He found that the impact of managing exchange rate to bring down inflation is rapid but short-lived whilst its is minimal but long lasting on output as compared to used of interest rate. The study therefore recommended that exchange rate management should be employed for controlling only temporary inflation shocks.

Kinful (2007) estimated the sacrificial ratio for Ghana using the historical account of disinflation and associate output losses using SVAR- aggregate supply curve analysis. He concluded that a 1 percent decrease in inflation results in an output loss 0.001 to 5.0 percent.

If however, there is consistency and credibility in the disinflationary process, the output losses could be transitory when the economy eventually adjusts to the inflation targeting framework.

Dabla-Norris and Floerkemeier (2006) used the VAR analysis to examine monetary transmission mechanisms in Armenia in the wake of the country intention to adopt the inflation targeting framework in the medium term. They found monetary policy to be limited in influencing real activities and inflation because of non-fully functional transmission mechanisms, particularly the interest rate channel remains weak. Mugume (2001) conducted similar studies in Uganda and obtained similar results as in Armenia.

Gul and Ekinci (2006) analyzed the empirical causal relationship between interest rate and inflation rate in Turkey. With a Granger causality test, they found a causal relationship between nominal interest rate and inflation rate with the direction of causality being from interest rate to inflation rate.

Frances and Owyang (2004) studied monetary policy in a Markov-Switching VECM, and the implication for disinflation and the price puzzle by allowing for the possibility of switches in the long run equilibrium in a cointegrated VARs. They found monetary policy to be alternating between long term growth and disinflation regimes. They also showed that regime switches has implications for disinflationary monetary policy.

Bawumia and Abradou-Otou (2003) adopted the error correction approach to study the relationship between monetary growth, exchange rates and inflation in Ghana. Their results confirmed a long run positive relationship between inflation and money supply as well as exchange rate, and a negative relationship with real income. They also showed inflation to adjust fairly rapidly to its long run equilibrium, a one month lag transmission effect of exchange rate on inflation, and 2 to 4 month lag effect of real income and money on inflation.

Calvo and Mishkin (2002) identified some features of developing and emerging market economies which include "weak fiscal and financial and monetary institutions, currency substitution and liability dollarization, and vulnerability to sudden stops of outside capital flows." Base on these features, Mishkin (2004) concluded that "inflation targeting is more complicated in emerging market countries and is thus not a panacea. However inflation targeting done right can be a powerful tool to help promote macroeconomic stability in these countries"

Erceg at el (1998) demonstrated the existence of monetary policy tradeoff between output and inflation variability and argued with an optimizing agent model that the tradeoffs of output gap and inflation is only absent if prices are sticky and wages are flexible. They also found that strict inflation targeting framework induces substantial output gap.

Hakkio (1986), argues that the relationship between interest rate and exchange rate tend to be positively correlated. The changes in the relationship between the two variables from negative to positive is due to changes in relative fundamental factors underlying the structural movement of interest rate and exchange rate.

CHAPTER THREE

METHODOLOGY AND CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter presents the methodological framework for the study. Specifically, the chapter describes the models conceptualised for the study, the inherent variables, their measurements, and sources of data employed. The chapter also states the estimation procedures and econometric software used for the estimation of the models which draws extensively from the Forward Looking Taylor's Rule (FLTR) [Following Agénor (2002), Clarida (2002), and Lunsford (2013)].

3.2 Specification of the Model

This section presents the specifications of the models and variables of the study.

3.2.1 The Forward Looking Taylor's Rule (FLTR)

According to Agénor (2002), the first step to understanding the inflation targeting framework and for empirical estimation is to analyze the relationship between the policy goals and instruments which influences the central bank's reaction function.

In the case of Ghana, the Bank of Ghana uses the short-term interest rate; the policy rate set by the monetary policy committee (MPC) as the key policy instrument. The Bank is more of a forward looking bias, and the policy rate is influenced by expected inflation instead of lagged inflation rate. In the light of this, the study follows Taylor (1993) forward looking rule as modified by Clarida et al (1999);

$$i_t^* = \alpha + \gamma_\pi (E_t\pi_{t+1} - \bar{\pi}) + \gamma_x x_t \quad (3.1)$$

Where,

$$\alpha = \bar{r} + \bar{\pi} \quad \text{and } \gamma_\pi > 1, \ \ \gamma_x > 0 \quad (3.2)$$

Where,

$i_{t,}^*$ is the target nominal interest rate for the policy instrument defined by the rule, for this study is the base rate.

$E_t\pi_{t+1}$ is the expected inflation,

$\bar{\pi}$ is the target inflation rate (assumed constant),

$\bar{r}$ is the long run equilibrium interest rate (assumed constant).

x_t is the output gap.

In equation 3.1, the policy instrument responds to expected inflation as in the case of the inflation targeting framework. The policy rate depends on the inflation gap as measured by the difference between expected inflation and the target inflation. It also depends on the output gap.

In consonance with FLTR, the macroeconomic variables of interest to the Bank of Ghana are the inflation rate, growth of output, and the interest rate. Although not directly implied in the policy rule; the exchange rate is also a significant variable, since inflation also affects exchange rate movements.

The policy rule can be modified by defining the error term as a monetary policy shock as in equation 3.3.

$$i_t^* = \alpha + \gamma_\pi (E_t\pi_{t+1} - \bar{\pi}) + \gamma_x x_t + \nu_t, \quad (3.3)$$

where v_t is the structural shock to monetary policy.

This modification facilitates the estimation of the shocks to the policy rule by defining the monetary policy shock as a regression error.

In the present study, equation 3.3 is further modified to permit estimation of a loss function as in 3.4.

$$i_t^* = \alpha + \gamma_\pi (\pi_t - \bar{\pi}_t) + \gamma_x x_t + v_t \qquad (3.4)$$

Where

i_t^* is the policy rate,

$(\pi_t - \bar{\pi}_t)$ is the year-on-year inflation gap with π_t as the actual year-on-year inflation and $\bar{\pi}_t$ as the target year-on-year inflation,

$x_t = (y_t - y_t^*)$ is the yearly output growth gap with y_t and y_t^* as the actual output and expected outputs growths respectively.

Since the inflation targeting policy framework started in 2002, the estimation of equation (3.4) will begin from 2002 data.

Unlike in equations 3.1 and 3.3 where the inflation gap is measured as the difference between expected inflation and the inflation target, in equation 3.4 the expected inflation is replaced by actual inflation since it is difficult to measure expected inflation in Ghana. Also, the inflation target is not assumed constant in equation 3.4. as in 3.1 and 3.3.

3.2.2 Sources of Data and Statistical/ Econometric Methods

The data for the study is obtained from multiple sources. This is because of the multiple variables being used and effects being measured by the study. The main sources include the Bank of Ghana, the IMF and World Bank, the Economic Community of West Africa (ECOWAS), the African Development Bank, the Ghana Statistical Service, and the Ministry of Finance and Economic Planning.

The study divides the period of focus into two sub-periods. The general period of the study is from 1992 to 2011. The period of inflation targeting is 2002 to 2011, whiles 1992 to 2001 is used as the initial period or the non-inflation targeting period.

Even though, the Bank of Ghana Act, 2002 (Act 612) gave it the operational independence and laid the grounds for formal adoption of the inflation targeting framework, the Bank formally adopted the policy in May 2007, but according to Wampah (2012), the Bank have been practicing the regime informally since 2002.

The study also compares changes in the behaviours and size of the averages and deviations of the inflation, exchange and interest rates and growth of output across these sub-periods to find out whether the framework has been successful in affecting the performance of these macroeconomic variables. Comparison of the standard deviations of the variables across the sub-periods of before targeting and targeting also evaluates whether the adoption of inflation targeting has contributed in lowering fluctuations in these variables. For output growth variability, the study uses the standard deviation of growth in output. The standard deviations of average yearly exchange rate and lending rate are used to measure exchange rate and

interest rate fluctuations respectively. These statistics are also compared with the averages and standard deviations of the variables in the West African sub-region for analysis.

It is not however sufficient to make significant conclusions from this simple statistical analysis of the trends of these variables across the study sub-periods. Whether inflation targeting has indeed influence their performances, especially in developing and emerging market economies like Ghana where there have been significant improvement in the macroeconomic environment within the last two decades, remains an empirical question. There may be other factors like global/regional decline in inflationary rate, favourable terms of trade, and increases in productivity leading to lower food prices and/or high earnings from primary exports. To empirically test the significance of the inflation targeting on the performance of these macroeconomic variables, the study uses the following model specifications of the inflation rate, output growth, interest rate and exchange rate as the operational model equations.

3.2.2.1 Estimating the Effect of Inflation Targeting on Inflation

For the effect of inflation targeting on the inflation rate, the study specifies the model;

$$ln\pi_t = \beta_0 + \beta_1 InfTag + \beta_2 lny_{t-1} + \beta_3 ln\pi_{t-1} + \beta_4 (lnr_{t-1} - ln\pi_{t-1}) + \mu_t \qquad (3.5)$$

Where π_t is inflation rates, y_{t-1} lagged output growth rate which measures the effect of output growth on inflation through the aggregate demand and supply channels, and also captures the effect of fluctuations in output and business cycle trends, π_{t-1} is lagged inflation rate which measures the effect of previous year inflation in determining current inflation. The lagged inflation also accounts for potential correlation between *InfTag* and past inflation performance. This takes into account the often argument that the probability of adoption and

performance of inflation targeting depends on the past inflation performance of the country. Countries with poor performance are argued to often find the framework more appealing and hence more likely to adopt inflation targeting than countries with historical good inflation performance. Countries with histories of poor inflation performance are also argued to perform better with the framework. $(lnr_{t-1} - ln\pi_{t-1})$ is lagged real interest rate which captures the effect of past real interest rate on inflation. $InfTag$ is a dummy which is equal to 1 after adoption of inflation targeting and 0 before the adoption.

Estimating the Rate of Adjustment of Actual Inflation to Inflation Targets

The study estimates the disinflationary process; the degree of adjustment of actual inflation rates to the inflation targets. The speed of adjustment is usually influenced by the policy decisions of the central bank to manage losses resulting from the disinflationary process base on their choices of the inflation targets and horizons. A very narrow target and short horizon may lead to losses in outputs and jobs although it may lead to faster speed towards convergence. A too slow speed to the process with a large target and long horizon may hurt the inflationary process with high inflationary persistence and expectations and low credibility of the central bank. This can also complicate future disinflationary efforts.

The adjustment can also be influenced by favourable macroeconomic environment such as the factors cited earlier like global decline in inflation rate, improvement in fiscal, financial and monetary institutions, especially in developing and emerging market economies, and the support of the public and markets for the disinflationary process.

The study uses the inflation targets and the actual inflation rates to estimate the rate of adjustment of actual inflation towards inflation targets across the study sub-periods; the non-

targeting (1992-2001) and the targeting period (2002-2011). To analyse the adjustment process across these periods, the following models are specified;

$$\Delta ln\pi^{*t} = b_1 + b_2\Delta ln\pi^{*a} + b_3 t + \omega_{1t} \qquad (3.6)$$

$$\Delta ln\pi^{it} = b_4 + b_5\Delta ln\pi^{a} + b_6 t + \omega_{2t} \qquad (3.7)$$

Where π^{*t} and π^{it} are the inflation targets during the non-targeting and targeting periods respectively. b_1 and b_4 are constant terms, π^{*a} and π^{a} are actual inflation rates during the non-targeting and targeting periods respectively, b_2, and b_5 are coefficients of adjustment which capture the rate of changes/adjustment of actual inflation to the targets, t_s are the trend factors which capture the falling averages of inflation, and ω_{ts} are the error terms. Equation 3.6 represents the non-targeting period and equation 3.7 represents the targeting period.

3.2.2.2 Estimating the Effect of Inflation Targeting on Growth of Output

For empirical estimation of the effect of inflation targeting on growth of output the study specifies the model;

$$lny_t = \alpha_0 + \alpha_1 InfTag + \alpha_2 lny_{t-1} + \alpha_3(lnr_{t-1} - ln\pi_{t-1}) + \alpha_4 lne_{t-1} + \varepsilon_t \qquad (3.8)$$

Where y_t is the current growth rate of output, $(r_{t-1} - \pi_{t-1})$ is the previous year real interest rate which measures the effect of the interest rate on growth of output, and lne_{t-1} is the lagged exchange rate effect.

3.2.2.3 Estimating the Effect of Inflation Targeting on Interest Rate and Exchange Rate

The study investigates the effect of inflation targeting on interest rate and exchange rate by estimating the following models;

The interest rate model is specified as;

$$lnr_t = \gamma_0 + \gamma_1 InfTag + \gamma_2(lnr_{t-1} - ln\pi_{t-1}) + \gamma_3 ln\pi_{t-1} + \upsilon_t \quad (3.9)$$

Where r_t is the nominal interest rate measured by the lending rate.

The exchange rate model is specified as;

$$lne_t = \lambda_0 + \lambda_1 InfTag + \lambda_2 lne_{t-1} + \lambda_3(lnr_{t-1} - ln\pi_{t-1}) + \lambda_4 ln\pi_{t-1} + \sigma_t \quad (3.10)$$

Where e_t is the exchange rate.

3.3 Specification of the Long Run Effect of Inflation Targeting

For the long run effect which include both direct and indirect effect, the study use the four dimensional model. This method is based on Lütkepohl (2005).

$$A_0 Z_t = \theta InfTag + A_1 Z_{t-1} + \Phi X_t + \upsilon_t \quad (3.11)$$

Where,

$Z_t = (\pi_t, y_t, e_t, \text{and } r_t)$,

$\boldsymbol{\theta} = (\beta, \alpha, \lambda, \text{and } \gamma)$ and X_t is a vector of all exogenous variables.

υ_t is a residual vector, and A_0, A_1 and Φ are coefficient matrices.

3.4 Estimation Procedures

The estimation process uses two approaches; for the regression analysis and for the long run analysis. In order to obtain the best possible results and allow for robust checking, the study uses the multiple regression and the seemingly unrelated regressions (SUR) estimation approaches for the estimation of the regression equations. The Johansen cointegration, Granger causality test and the VAR approaches are used for the long run analysis.

The seemingly unrelated regression (SUR) estimation approach proposed by Zellner (1962) is used because although each equation measures the effect of inflation targeting on different variables and with variant independent variables, they share close conceptual relationships as in the literature and specifications. Since there may be correlation in the error terms; contemporaneous correlation; the SUR is the best approach for estimation. The SUR estimation approach also have the advantage of been generalized to simultaneous equations estimation approach as it allows for the right-hand regressors (independent variables) to be endogenous as well. If the right-hand-side regressors in each equation are different as well; the parameters can be best and consistently estimated with the SUR estimation approach.

The SUR method has the advantage of providing consistent and efficient estimates by combining information from the various equations. The method can also allow for imposition and/or test of restrictions that involve parameters in different equations. The estimation is done with the E-views 5 software package.

Since unit roots are found in time series data, implying non-stationarity of variables, the study conducts unit root tests using the Augmented Dickey-Fuller (ADF) test procedure.

The Johansen cointegration (1988) approach is used for the study. The Engle-Granger cointegration approach could also be used but it could be problematic. The Engle-Granger

cointegration estimation has some drawbacks that could impair the results of the estimation. First, the cointegration vector does not include the dependent variable as a vector. This might give inconsistent estimates and leads to spurious results. Second, the Engle Granger cointegration cannot also detect if they are more than one cointegration relations. Given the fact that the main variables of the study could have more than one cointegrating relations, the Eagle-Granger approach is not the best approach.

With the Johansen cointegration approach, the long run relationships can be estimated by specifying the model in the vector autorgression (VAR) form to test for number of cointegration directly. The VAR is estimated accordingly, in addition to performing the Granger causality test.

3.5 Measurement of Variables

The growth rate of output is measured by yearly growth rate of real GDP to analyse the effects of the framework on growth in output in real terms. The output gap is measured by the difference between actual and projected output growth rates. Projected growth rate of output uses the target growth rates in the yearly budget statements.

Due to the fact that the US dollar is the most traded foreign currency in Ghana, the study measures the exchange rate by the Ghana cedi to the US dollar (GHC/USD). The exchange rate is included to capture its effect on the inflation targeting, especially since deterioration in exchange rates has been a bane of Ghana's monetary stance. Also in a small opened economy like that of Ghana, the exchange rate serves as an indicator of future output and inflation trends and, therefore, a target of monetary policy. Further, as an emerging economy, the

Ghanaian economy is heavily dollarised and the exchange rate may therefore have significant effect on inflation as in most transitional and emerging economies.

For the estimation of the policy rule, interest rate is measured by the base rate. The yearly average lending rate is used for the other interest rate equations since the public and the markets in Ghana easily identify with the lending rate than any other kind of measure of the interest rate. The inclusion of interest rate will capture two components on output growth. First, investment is an important component of output and can also influence fluctuations overtime. Since investment is a function of the interest rate, inclusion of the interest rate will help determine the impact of the fluctuations in investment on both growth of output and inflation variability in the short run. Second, interest rate also influences the level of output and general prices through consumption, especially, durable goods.

Actual inflation rate is measured by the year-on-year inflation rate. The inflation targets are obtained from the annual budgets statements. As stated earlier, the *InfTag* is a dummy variable measuring the effect of inflation targeting on macroeconomic performance. *InfTag* is 0 in the non-targeting period (1992-2001) and 1 in the targeting period (2002-2011).

All the variables are converted from yearly to quarterly data. The inflation rate, interest rate and exchange rate are all converted with constant match-sum average method from low to high frequency. The growth rate in output is converted with linear match-last method with the assumption of linear growth in real GDP in a year.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF EMPIRICAL RESULTS

4.1 Introduction

This chapter presents the empirical results from the analysis of the data and discussions of the study. The chapter is in two main parts. The first part presents the trends, statistical and regression analyses of the behaviours of inflation, growth in output, interest rate and exchange rate during the period and across the sub-periods of the study. The regression analyses include both multiple regression for the loss function and the seemingly unrelated regression (SUR) estimation for the other models.

The second part presents the long run analyses which employ the Granger causality test, Johansen cointegration test, the vector autoregressive approach and the impulse response analysis.

The data is estimated with the E-views 5 software package. The results are presented in tables and graphs. The results in tables 4.2, 4.4, 4.6 and 4.7 are the SUR estimates. The full SUR results are presented in appendix A2.

4.2 The Loss Function

The loss function of the central bank influences its choice of the inflation target, the time horizon and the policy instrument. The study uses the base rate, the output gap, and the inflation gap to estimate the loss function of the Bank of Ghana in the spirit of FLTR using a quarterly data of these variables from 2002:1-2011:4 since the inflation targeting framework started in 2002 and also data for the base rate is only available from 2002.

The estimates of the loss function (equation 3.4) which was derived from the FLTR is presented in equation 4.1.

$$i_t^* = 16.83 + 0.14(\pi_t - \bar{\pi}_t) - 1.16x_t \qquad (4.1).$$

Se	(0.78)	(0.18)	(0.60)
t	(21.47)	(0.77)	(-1.91)

n = 40 **D-W = 0.18**
R^2 =10.16 **SER =3.77**
Adjusted R^2 = 5.30

From the equation, the Bank of Ghana policy rate responds positively to the inflation gap and negatively to the output gap. The coefficient of the output gap is significant at 10% whilst that of the inflation gap is not significant.

However, with high significant constant and very low R^2, there could be other factors such as the interest rate and exchange rate which influence the policy rate than just the inflation and output gaps. The full results of the estimates of the loss function, equation 3.4, are presented in appendix A1.

A close observation of the quarterly movements of the output and inflation gaps suggests that both variables have had negative relationships with the policy rate in one period or other as shown in fig. 4.1.

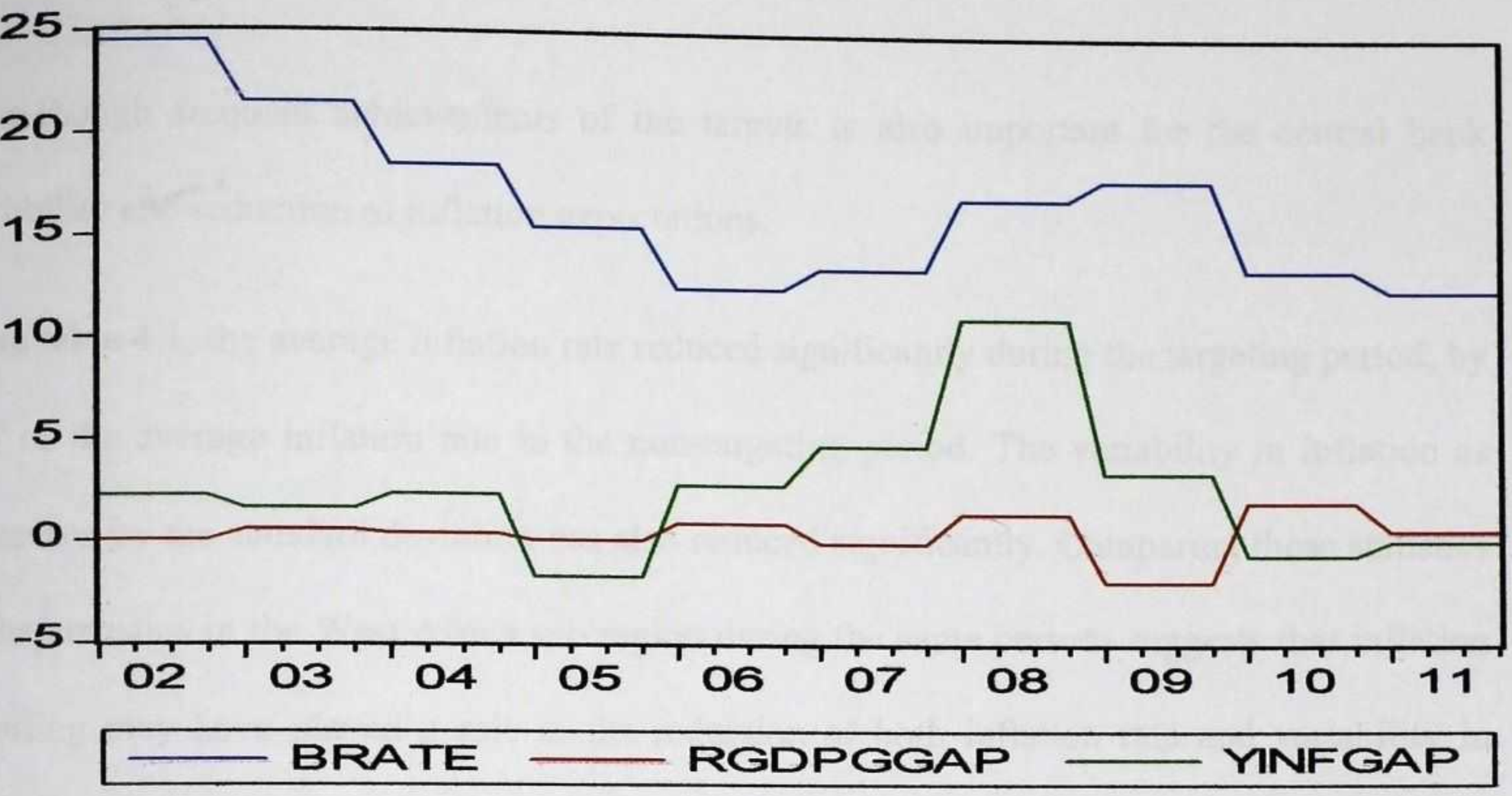

Fig. 4.1: Graph of the base rates (BRATE), inflation gap (YINFGAP) and real GDP growth gap (RGDPGGAP).

From fig. 4.1, the inflation gap however seems to respond more to movement in the base rate than the output gap.

4.3 Effect of Inflation Targeting on Actual Inflation rate

As the main goal of monetary policy, price stability is synonymous with reduction and stability in inflation rate in most economies. However, most inflation targeting central banks move beyond just achieving reductions in inflation to ensuring overall macroeconomic stability and growth. As such, narrow misses of the inflation target may be accepted on the dictates of the economy for other macroeconomic fundamentals to remain sound.

For price stability to prevail there should be consistent disinflation in countries with historically high inflationary trends like Ghana. It will therefore be shallow to limit the successes of the inflation targeting framework just to the successes of achieving the inflation targets within the horizons. The focal point of assessing the success of the framework will be how it has succeeded for disinflation and not the frequencies of achieving the inflation targets

even though frequent achievements of the targets is also important for the central bank credibility and reduction of inflation expectations.

From table 4.1, the average inflation rate reduced significantly during the targeting period, by half of the average inflation rate in the non-targeting period. The variability in inflation as measured by the standard deviation has also reduced significantly. Comparing these statistics to the statistics in the West Africa sub region during the same periods suggests that inflation targeting may have played a role in the reduction of both inflation rate and variability in Ghana. Even though there have been reduction in average inflation in the West Africa sub region during this periods, this has been minimal as compared to that of Ghana.

Variability of inflation seems to be higher in Ghana as compared to that of the West Africa sub region. However, Ghana has also achieved significant reduction in variability during the targeting period as compared to reductions in spread of inflation in the West Africa sub region over the same period. Table 4.1 presents the means and standard deviations of the inflation rate across the two sub periods.

From table 4.1, the mean inflation target has also reduced during the targeting period as compared to that of the non-targeting period. Variations in the inflation target have also reduced, albeit minimally. The inflation gap which measures the differences between actual inflation and target inflation also reduced significantly from 12.85 during the non-targeting period to 2.60 during the targeting period. These very large reductions in the mean and variation in the inflation gap suggest that the Bank of Ghana have reduced its frequencies as well as margins of misses of the inflation targets during the targeting period. In effect, inflation targeting has narrowed the inflation targets than other monetary regimes in the past.

Table 4.1: Means and standard deviations of actual inflation, 1992-2001 and 2002-2011

Variable	1992-2001	2002-2011
Mean actual inflation	29.08	14.03
Standard deviation of actual inflation	17.33	4.59
Mean target inflation	16.30	11.12
Standard deviation of target inflation	5.79	4.46
Mean inflation gap	12.85	2.60
Standard deviation of inflation gap	16.69	3.57
Mean inflation (West Africa)	11.09*	10.09
Standard deviation of inflation (West Africa)	5.34*	2.40

The mean and standard deviation of the inflation rates in West Africa is between the periods of 1995-2001 as a result unavailability of data.

Source: Computed with E-views 5 package for the SUR estimation

For the empirical analysis of the effect of inflation targeting on inflation, the study estimates equation 3.5. The results are presented in table 4.2.

From the results; one year lagged growth in output has a significant negative effect on the inflation rate. This means consistent growth of the economy can contribute to disinflation from the medium to long term.

The real interest rate also has a significant negative lag effect on inflation rate. This means that increases in the nominal interest rate with decreases or corresponding relatively low increases in the inflation rate will reduce the current actual inflation rate. On the hand if the inflation rate increases faster than the nominal interest rate, real interest rate will be low, and the current actual inflation rate will increase. Since the nominal interest rate has consistently remained higher relative to actual inflation rate over the last few years, it means the real interest rate has also consistently been increasing and this has contributed to disinflation.

Table 4.2: Estimates of the effects of inflation targeting on inflation rate ($ln\pi_t$), (1992-2011)

Variable	Parameter	Coefficient	p-values
Constant	β_0	3.419	0.000
$InfTag$	β_1	-0.225	0.004
$ln\pi_{t-1}$	β_2	0.1574	0.408
lny_{t-1}	β_3	-0.310	0.042
$(lnr_{t-1} - ln\pi_{t-1})$	β_4	-0.596	0.001

n = 76 SER = 0.23
R^2 = 0.825 Adjusted R^2 = 0.815
D-W = 1.87

Source: Computed with E-views 5 package for the SUR estimation

In the graph below of inflation rate (LN_AYINF), GDP growth rate (LN_LAGDPGR), and interest rate (LN_LINTRATE), output growth rate rises gradually whilst the inflation rate reduces gradually. The reductions in inflation rate and interest rate seem to have positive relationship; with some fluctuations in the reduction in inflation rate. The curve also shows severe fluctuations in all the variables.

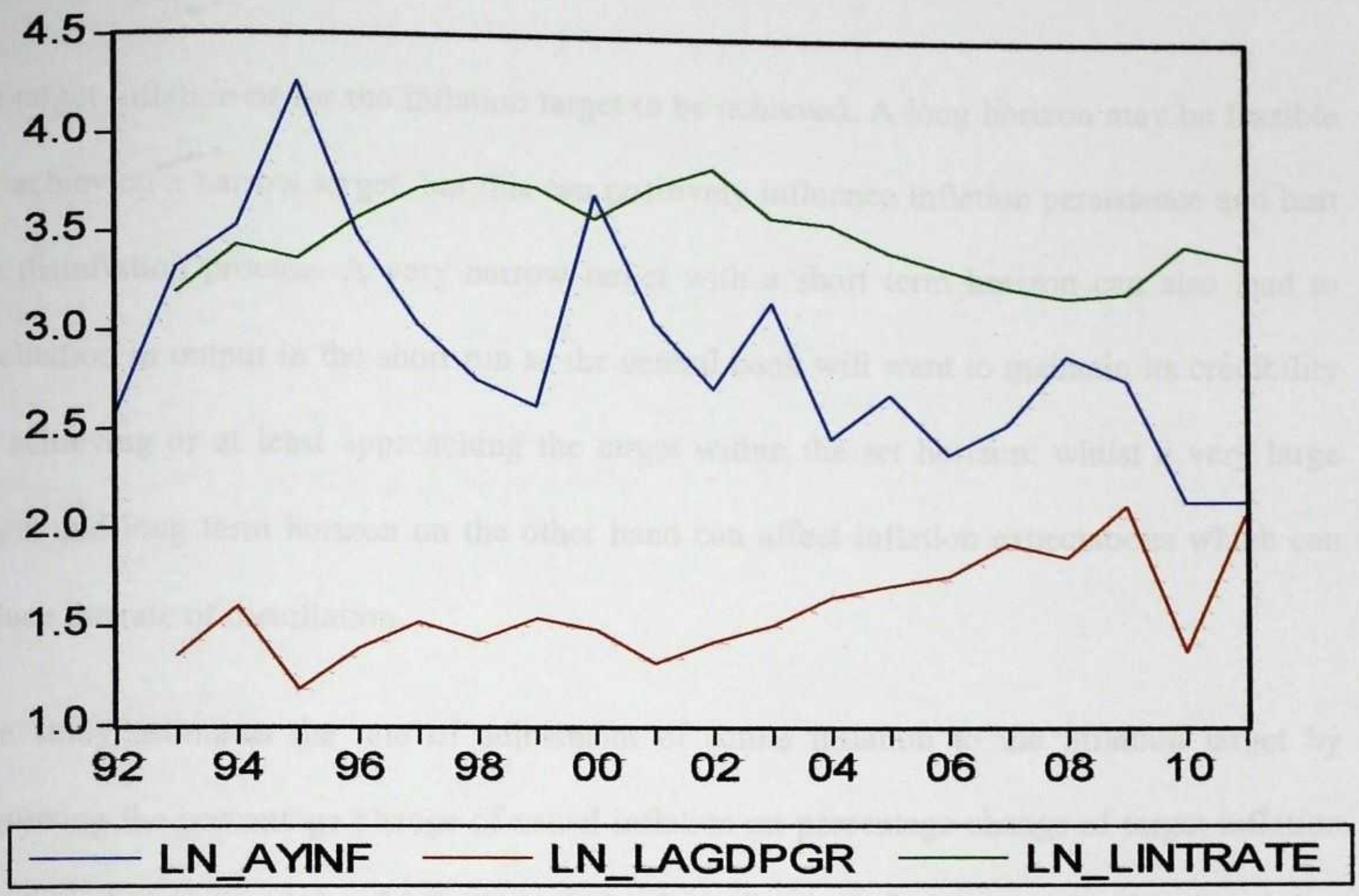

Fig. 4.2: Graph of the inflation rate, output growth and interest rate.

The results in table 4.2 show significant inflation inertia as measured by the constant which can influence inflation expectations and persistence. One year lagged inflation rate has insignificant positive effect on inflation which means insignificant inflation persistence. Finally, from the results, the inflation targeting framework has significant effect on disinflation as shown by the coefficient of the *InfTag*.

The Rate of Adjustment of Target Inflation to Actual Inflation

The rate at which the actual inflation adjusts or approaches the target inflation depends on three factors; the time horizon, the margin of the target, and the policy instrument. The effectiveness of the policy instrument which can be influenced by the macroeconomic dynamics of the economy determines how long it takes for the actual inflation to converge to

the target inflation or for the inflation target to be achieved. A long horizon may be feasible for achieving a narrow target, but this can positively influence inflation persistence and hurt the disinflation process. A very narrow target with a short term horizon can also lead to fluctuation in output in the short run as the central bank will want to maintain its credibility by achieving or at least approaching the target within the set horizon; whilst a very large target and long term horizon on the other hand can affect inflation expectations which can reduce the rate of disinflation.

The study estimates the rate of adjustment of actual inflation to the inflation target by regressing the percentage change of actual inflation on percentage change of target inflation in a period (equation 3.6 and 3.7). The results show that the inflation targeting framework has improved the rate of adjustment of actual inflation to target inflation as already indicated in the reductions in the mean and variability of the inflation gap in the statistical analysis above.

For the non-targeting period, the rate of adjustment of actual inflation to target inflation is 25.9% at a given quarter. This is significant at 5% level. Equation 4.2 shows the rate of adjustment in the non-targeting period.

$$\Delta ln\pi^{*t} = 0.06 + 0.259\Delta ln\pi^{*a} - 0.0008t \qquad (4.2)$$

Se	**(0.10)**	**(0.12)**	**(0.00)**
t	**(0.60)**	**(2.21)**	**(-0.19)**

n = 39
R^2 = 12.18 **D-W = 2.05**
Adjusted R^2 = 7.29 **SER = 0.30**

The targeting period shows a significant increase in the rate of adjustment of actual inflation to the inflation target. This means that inflation targeting has increased the disinflation process as reflected in the reductions of both the inflation gap and actual inflation. The rate of

adjustment in the targeting period is 76.5% at 1% significant level which is more than double the rate of adjustment in the non targeting period. The estimated equation of the rate of adjustment for the targeting period is presented in equation 4.3.

$$\Delta ln\pi^{it} = 0.003 + 0.765\Delta ln\pi^{a} + 0.0004t \quad (4.3)$$

Se	(0.00)	(0.17)	(0.00)
t	(0.04)	(4.42)	(0.17)

n = 39
R^2 = 35.32 **D-W = 2.01**
Adjusted R^2 = 32.72 **SER = 0.18**

The R^2 also increased from 12.18 percent in the non-targeting period to 35.32 percent in the targeting period. Although the trend factor in both targeting and non-targeting period are insignificant, there have been change from negative to positive of the factor in the targeting period. This means the change of the rate of adjustment may increase with time in the targeting period unlike in the non targeting period where it reduces with time.

In the estimation of the rate of adjustment, several factors that could affect disinflation were ignored since the study main concern is on the inflation and output gaps and how the actual inflation approaches the target inflation. This is obviously reflected in the very low R^2 obtained in the estimation. The full results of the estimation of the rates of adjustments for both periods are shown in appendix A3.

4.4 Effect of Inflation Targeting on Growth in Output

One of the criticisms and raging debate of the inflation targeting framework is its possible effect of reducing output growth base on the theoretical basis of the Philips curve. Critics

argue that inflation targeting may hurt growth in output and increase output volatility/variability. This debate is also base on the typical policy reaction function of central banks which mostly target the short term interest rate as the key policy instrument. Since increasing the policy rate to control inflationary pressures can stifle investment and hence growth, it has been mostly argued that the framework can be 'anti-growth'.

However, from the statistical analysis, inflation targeting has been positive to growth of output in Ghana. The mean output growth is higher in the targeting period than in the non targeting period. Variability in output has, however, increased in the targeting period relative to the non-targeting period as measured by the standard deviation of actual growth rate of output. There have also been increases in the variations of the target growth rate during the targeting period relative to the non-targeting period. These results are presented in table 4.3

Table 4.3: Means and standard deviations of growth rate, 1992-2001 and 2002-2011

Variable	1992-2001	2002-2011
Mean actual output growth	4.20	7.01
Standard deviation of actual output growth rate	0.50	3.99
Mean target growth rate	4.98	6.65
Standard deviation of target growth rate	0.41	2.28
Mean output growth gap	-0.78	0.40
Standard deviation of output growth gap	0.64	1.91
Mean growth rate (West Africa)	3.29	7.11
Standard deviation of growth rate (West Africa)	1.88	2.60

Source: Computed with E-views 5 package

The mean output gap is positive, although minimal, in the targeting period as compared to negative output gap in the non-targeting period suggesting that in marginal terms there have

been achievements of the growth targets during the targeting period than the non-targeting period. There has, however, been increase in variability of the output gap during the targeting period indicating increased variability in growth rates in Ghana as in the West Africa sub region. The target growth rates have also increased during the targeting period.

It is not however convincing to attribute this performance to the inflation targeting framework as there has been general growth in output in the West Africa sub region during the same period. There could be other factors in the global economic environment like increased commodity prices of primary export, and significant inflows of capital and aid.

Equation 3.8 is estimated for the empirical analysis of the effects of inflation targeting on growth of output. The results are presented in table 4.4.

Table: 4.4: The effect of inflation targeting on growth of output (lny_t), (1992-2011)

Variable	Parameter	Coefficient	p-values
Constant	α_0	`-0.053	0.463
$InfTag$	α_1	0.020	0.543
lny_{t-1}	α_2	1.019	0.000
$(lnr_{t-1} - ln\pi_{t-1})$	α_3	0.039	0.079
lne_{t-1}	α_4	-0.009	0.567

n = 76 SER = 0.08
R^2 = 0.935 Adjusted R^2 = 0.931
D-W = 0.67

Source: Computed with E-views 5 package for the SUR estimation

As noted earlier, inflation targeting does not come at a cost to the growth of output but rather has an insignificant positive marginal effect on growth, at least indicating no tradeoff between disinflation and growth of output. The statistical analyses also showed increased

growth rates of output during the targeting periods with corresponding reduction in inflation rates.

Previous output growth also has significant positive effect on growth. This is expected, as growth in output in the previous years may increase current output growth through the aggregate demand channel; consumption and investment.

The real interest rate and exchange rate both have insignificant minimal and opposing effect on output; real interest rate has negative effect whilst exchange rate has positive effect.

4.5 Effect of Inflation Targeting on Interest Rate and Exchange Rate

One of the key factors of price stability is interest rate and exchange rate stability. Interest rate has historically high values in Ghana. The Ghana cedi has also consistently depreciated over the years despite several policy interventions.

From table 4.5, the mean interest rate measured by average lending rate is lower in the targeting period than in the non targeting period. There is also reduction in variability of the interest rate by almost half in the inflation targeting period.

The exchange rate has, however, increased under inflation targeting with little changes in exchange rates variability which was relatively lower under the non-targeting period. The exchange rate seems not respond to the effects of disinflation and reduction in interest rate; the rate of depreciation of the cedi is higher under the inflation targeting regime.

Table 4.5: Means and standard deviations of interest rate and exchange rate, 1992-2001 and 2002-2011

Variable	1992-2001	2002-2011
Mean interest rate	37.22	29.44
Standard deviation of interest rate	7.29	4.18
Mean exchange rate	0.26	1.11
Standard deviation of exchange rate	0.25	0.28

Source: Computed with E-views 5 package

The study empirically estimated equation 3.9 to determine the effect of inflation targeting on interests rate. The results are presented in table 4.6.

As can be observed from the constant, the interest rate has high inertia which makes reductions over the years a difficult assignment for the monetary authorities. Although there have been significant reduction in the mean interest rate as well as variability during the inflation targeting period compared to the non-targeting period, Ghana still experiences relatively high interest rate with the mean average lending rate of 27% in the targeting period.

Fig. 4.6: Estimates of the effect of inflation targeting on interest rate (lnr_t), (1992-2011)

Variable	Parameter	Coefficient	p-values
Constant	γ_0	0.522	0.000
$InfTag$	γ_1	-0.051	0.005
$ln\pi_{t-1}$	γ_2	0.861	0.567
$(lnr_{t-1} - ln\pi_{t-1})$	γ_3	0.843	0.000
n = 79	SER = 0.06		
R^2 = 0.905	Adjusted R^2= 0.901		
D-W = 2.07			

Source: Computed with E-views 5 package for the SUR estimation

The previous year's real interest rate has a significant positive effect on current interest rate. This reveals the role of interest rate persistence on current interest rate levels. This means the term structure of the interest rate is backward looking. The inflation targeting framework has a significant marginal effect on interest rate.

The exchange rate behaves similarly to the interest rate. It has higher inertia as measured by the constant and persistence as measured by lag exchange rate. The Ghana cedi has seen significant deterioration over the period of both targeting and non targeting period. From the statistical analysis, the rate of depreciation as well as volatility of the exchange rate have increased during the targeting period than in the non-targeting period, the only macroeconomic variable to exhibit this trend.

The real interest rate has a significant negative effect on the exchange rate. This is probably as a result of the opened nature of the financial sector in Ghana. As a small economy with such an opened and liberalized financial system, the interest rate may have significant effect on the exchange rate as fluctuation in foreign portfolio investments may influence the domestic lending rate.

The effect of the constant and lagged exchange rate is also high in influencing the exchange rate indicating significant inertia and persistence. The lag effect of inflation on the interest rate is also significantly negative. Although inflation targeting has negative effects, this is not significant.

The results of the estimates of equation 3.10 are presented in table 4.7.

Table 4.7: Estimates of the effects of inflation targeting on exchange rate (lne_t) (1992-2011).

Variable	Parameter	Coefficient	p-values
Constant	λ_0	0.439	0.015
$InfTag$	λ_1	-0.053	0.335
$ln\pi_{t-1}$	λ_2	-0.106	0.022
$(lnr_{t-1} - ln\pi_{t-1})$	λ_3	-0.111	0.016
lne_{t-1}	λ_4	0.991	0.000

n =79 SER = 0.13
R^2 = 0.987 Adjusted R^2 = 0.986
D-W= 2.29

Source: computed with E-views 5 package

4.6 The Long Run Analysis

This section presents the long run analysis of the effect of inflation targeting on the macroeconomic variables. The econometric estimation techniques include the Johansen multivariate cointegration, the Granger causality test, the vector autoregressive analysis, and the impulse response analysis. It is however imperative to first of all conduct a unit root test to test the stationarity of the variables, since time series variables of this nature can be non-stationary.

4.6.1 Unit Root Tests

Unit root test of stationarity of all the variables is conducted with the Augmented Dickey Fuller (ADL) test at 5 percent significant level.

All the variables appear to be non stationary with the graphical inspections shown in appendix B. There are growth trends as well as volatility in the variables, particularly the interest rate and inflation rate. The ADF unit root test at 5% significance level is applied to test the null hypothesis of unit root.

H_0: a variable is non-stationary or has a unit root,

H_1: a variable is stationary or has no unit root.

The results are presented in table 4.8

All the variables are non stationary at 5% significance level. Apart from the growth rate of output which is I(2), all the price variables; the inflation rate, exchange rate and interest rate are I(1).

Table 4.8: ADF unit roots test of stationarity

Variable	ADF test statistics	t-statistics	p-values	I(O)
Real GDP growth rate				***I(2)***
Levels	**0.803670**	**-2.905519**	**0.9934**	
First difference	**-2.352109**	**-2.905519**	**0.1592**	
Second difference	**-6.462622**	**-2.905519**	**0.000**	
Inflation rate				***I(1)***
Levels	**-2.406047**	**-2.898623**	**0.1434**	
First difference	**-5.556551**	**-2.900670**	**0.0000**	
Interest rate				***I(1)***
Levels	**-1.674242**	**-2.898623**	**0.4403**	
First difference	**-8.719525**	**-2.899115**	**0.0000**	
Exchange rate				***I(1)***
Levels	**0.061515**	**-.2898623**	**0.9607**	
First difference	**-9.5990**	**-2.899115**	**0.0000**	

I(O) is the order of integration

Source: Computed with E-views 5 package

4.6.2 Lag Selection

Monetary policy actions take time to effect changes in the economy. As such, the effect of most policy actions on current macroeconomic variables come with lags.

The number of lags for each variable is determined in the model. The estimates are shown in appendix C1. The criteria for lag selection is base on the estimates of the sequential modified LR test statistic (LR), final prediction error (FPE), akaike information criterion (AIC), Schwarz information criterion (SC) and the Hannan-Quinn criterion (HQ), each at 5% level of significance. Apart from SC and HQ which indicated 1 and 2 maximum lag(s) respectively, the other criteria indicated 5 maximum number of lags. As such the study includes 5 lags in the Johansen cointegration and the vector autoregressive (VAR) model.

4.6.3 The Johansen Cointegration Test

The Johansen cointegration test is employed to estimate long run relationship between the variables. The long run relationship of the variables can determine the effect of monetary policy such as inflation targeting. If there is any long run relationship between/among any of the variables, changes in any variable can affect the long run movement in the other(s).

The Johansen test is employed because it includes all variables in the cointegration process and also determines the number of cointegration relationships. The results of the cointegration test are presented in table 4.9 and 4.10. Table 4.9 presents estimates of unrestricted cointegration rank test (traces).

All the critical values are greater than the corresponding trace statistics at 5% significance level. All the probability values are also greater than 5%. This means that there is no long run relationship among the variables at 5% significant level.

Table 4.9: Estimates of unrestricted cointegration rank test (traces)

Hypothesised no. of CE(s)	Eigenvalue	Trace Statistics	Critical Value (5%)	P-value
None	0.305448	66.46423	69.81889	0.0899
At most 1	0.290921	40.58557	47.85613	0.2022
At most 2	0.153190	16.17662	29.79707	0.6998
At most 3	0.031164	4.370815	15.49471	0.8714
At most 4	0.029458	2.122928	3.841466	0.1451

Source: Computed with E-views 5 package

Table 4.10 presents the maximum Eigenvalue test. The maximum Eigenvalue test results are similar to the trace test results. All the critical values at 5% percent significant level are greater than the corresponding mixed Eigen statistic. This means that there is no cointegration among the variables at 5% significance level. Since there is no long run relationship among the variables, the study conducts an unrestricted VAR test and impulse response analysis.

Table 4.10: Estimates of unrestricted cointegration rank test (maximum Eigenvalue)

Hypothesised No. of CE(s)	Eigenvalue	Mixed-Eigen Statistic	Critical Value (5%)	p-value
None	0.305448	25.87866	33.87687	0.3282
At most 1	0.290921	24.40895	27.58434	0.1211
At most 2	0.153190	11.80581	21.13162	0.5669
At most 3	0.031164	2.247887	14.26460	0.9839
At most 4	0.029458	2.122928	3.841466	0.1451

Source: Computed with E-views 5 package

4.6.4 Granger Causality Test

The Granger causality test is conducted to further test for long run relationships between the variables.

It is the test for lagged effect of each of the variables on the others. Since there are lags in monetary policy and the relationships of these macroeconomic variables are important for the goal of price stability, the test of Granger causality will give an indication of whether the lag values of each variable affect others and whether policy effect on a variable will affect the other with possible lags. The results of the Granger causality test are presented in table 4.11.

From the causality analysis there are only three variables which Granger-cause each other at 5% significant level. These are mainly the price variables; the exchange, interest and inflation rates. Both interest rate and inflation rate Granger cause each other. Exchange rate also Granger causes the interest rate but not the opposite.

Growth in output does not however Granger causes any variable; neither do any of the price variables Granger causes growth in output.

Table 4.11: Estimates of the Granger causality test

Null hypothesis	F-statistics	p-value
Inflation rate do not Granger cause growth rate of output	0.02764	0.99997
Growth rate of output do not Granger cause inflation rate	0.72362	0.65249
Exchange rate do not Granger cause growth rate of output	0.81866	0.57692
Growth rate of output do not Granger cause exchange rate	0.34150	0.93121
Interest rate do not Granger cause growth rate of output	0.17695	0.98897
Growth rate of output do not Granger cause interest rate	0.53056	0.80761
Exchange rate do not Granger cause inflation rate	1.23260	0.30011
Inflation rate do not Granger cause exchange rate	0.41122	0.89154
Interest rate do not Granger cause inflation rate	3.53769	0.00313
Inflation rate do not Granger cause interest rate	2.53318	0.03408
Interest rate do not Granger cause exchange rate	0.86870	0.53661
Exchange rate do not Grange cause interest rate	2.88540	0.01174

Source: Computed with E-views 5 package

4.6.5 Vector Autoregressive (VAR) Analysis

The vector autoregressive test help determine the effect of lags of all the variables on each other as endogenous variables. Since there is no cointegration among the variables, an unrestricted VAR analysis helps establish further relationship among them and also allow for impulse response analysis. The results of the VAR estimation of the four equations are presented in table 4.12.

From the VAR analysis, the growth rate of output is only significantly affected by its lag values at 5% level. The effect is positive with the first lag and negative with the second lag. The positive effect is however more larger and significant than the negative effect of the second lag.

The VAR estimates of inflation rate are similar to the results of the SUR analysis. There is high inflation inertia and persistence as measured by the constant and the first lagged inflation rate. The fourth and fifth lag values of the interest rate also have significant but opposing effect on the inflation rate; whilst the fifth lag has positive effect, the fourth lag has a negative effect.

As in the Granger causality analysis, only the inflation rates and exchange rates have significant lag affect on the interest rates apart from its own lags. For the exchange rates, only interest rate and its own lags have significant effect on it.

Table 4.12: Results of VAR estimations

Independent Variables	Dependent variables			
	y_t	π_t	r_t	e_t
Constants	-1.256	31.90	-4.899	0.074
	(0.248)	(0.072)	(0.401)	(0.682)
y_{t-1}	1.761	0.534	0.362	0.008
	(0.000)	(0.830)	(0.663)	(0.762)
y_{t-2}	-0.734	-0.784	0.002	-0.006
	(0.011)	(0.876)	(0.999)	(0.909)
y_{t-3}	-3.85E-12	-6.78E-12	3.62E-11	-5.60E-12
	(1.000)	(1.000)	(1.000)	(1.000)
y_{t-4}	-0.244	-3.683	-0.642	0.001
	(0.404)	(0.476)	(0.708)	(0.978)
y_{t-5}	0.293	3.228	1.305	0.002
	(0.095)	(0.293)	(0.205)	(0.952)
π_{t-1}	0.006	0.744	0.024	-0.001
	(0.45)	(0.000)	(0.594)	(0.685)
π_{t-2}	0.0003	-0.002	0.003	1.79E-05
	(0.974)	(0.987)	(0.942)	(0.990)
π_{t-3}	0.0003	-0.002	0.003	1.79E-05
	(0.947)	(0.987)	(0.942)	(0.990)
π_{t-4}	-0.002	-0.139	0.121	-0.001
	(0.795)	(0.331)	(0.012)	(0.479)
π_{t-5}	0.003	0.091	-0.052	0.0003
	(0.649)	(0.429)	(0.185)	(0.787)
r_{t-1}	-.0.007	0.099	0.731	0.002
	(0.759)	(0.813)	(0.000)	(0.634)
r_{t-2}	0.002	-0.015	0.022	0.0001
	(0.952)	(0.975)	(0.893)	(0.982)
r_{t-3}	0.002	-0.015	0.022	0.0001

		(0.952)	(0.975)	(0.893)	(0.982)
r_{t-4}		0.002	-1.923	-0.090	-0.009
		(0.952)	(0.000)	(0.573)	(0.074)
rt-5		0.0003	1.404	0.261	0.006
		(0.988)	(0.001)	(0.050)	(0.144)
e_{t-1}		-0.346	2.951	5.022	0.876
		(0.663)	(0.832)	(0.576)	(0.000)
e_{t-2}		-0.041	0.374	-0.544	-0.003
		(0.966)	(0.983)	(0.924)	(0.987)
e_{t-3}		-0.041	-0.374	-0.544	-0.003
		(0.966)	(0.984)	(0.924)	(0.987)
e_{t-4}		0.479	-8.825	5.767	0.493
		(0.625)	(0.609)	(0.319)	(0.006)
e_{t-5}		0.257	-3.913	-11.781	-0.409
		(0.757)	(0.7880	(0.016)	(0.007)
n	=	72	72	72	7
R^2	=	97.78	86.28	92.85	98.54
Adjusted R^2	=	0.969	0.809	0.901	0.980
D-W	=	1.82	1.71	2.11	1.82
SER	=	0.37	6.49	2.17	0.07

P-values in parenthesis,
Source: computed with E-views 5 package

4.6.6 Impulse Response Analysis

From the VAR analysis, the study estimates the impulse response of each variable to one Cholesky standard deviation shock to another into a two-year period (four quarters) ahead. The impulse response analysis is relevant because estimated coefficients of the VAR models are not easy to interpret meaningfully. The graphs of the impulse response analysis are shown in figure 4.3.

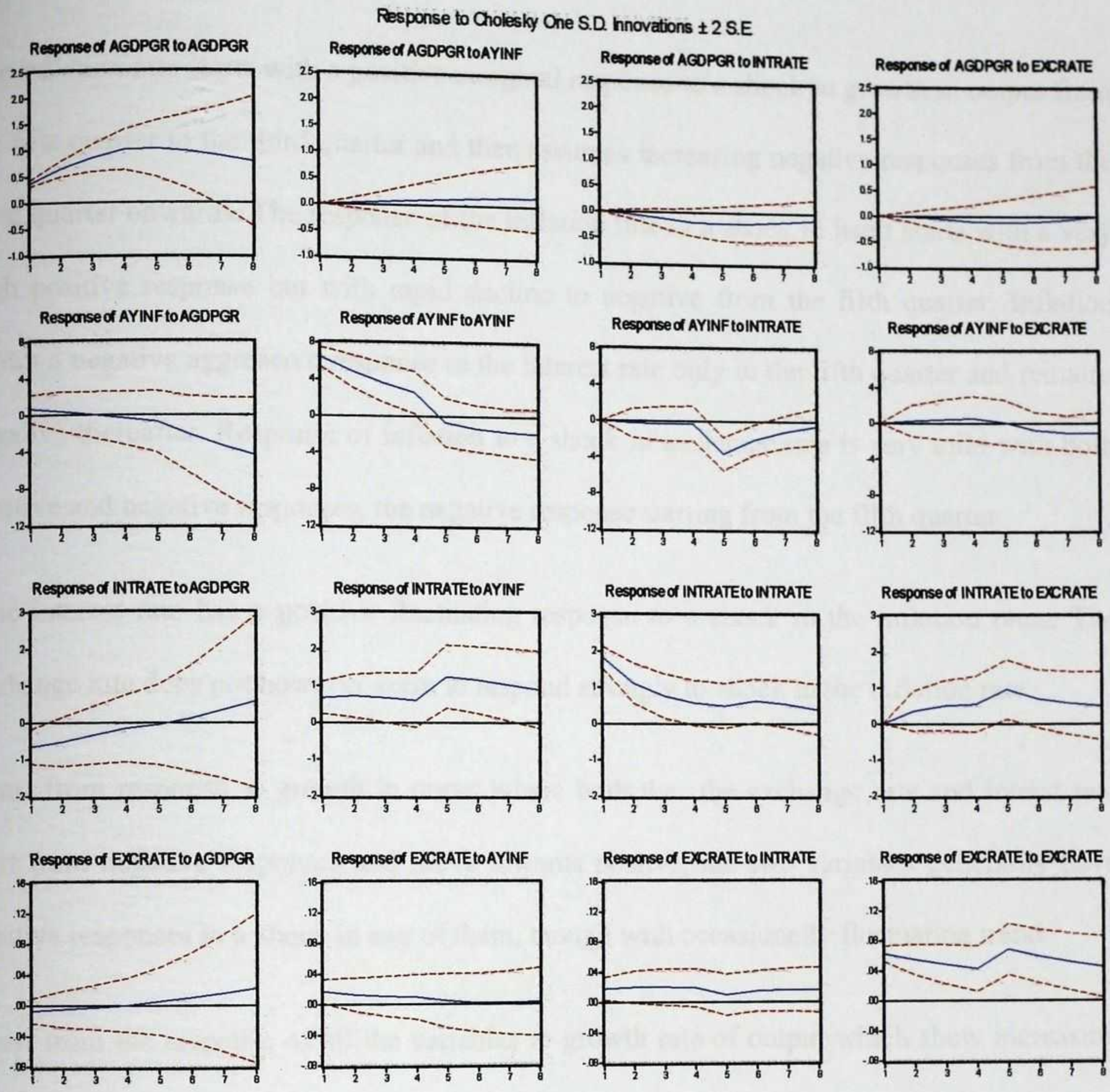

Fig.: 4.3 Impulse responses

Response of output growth to one standard deviation shock in growth in output is positive with output growth rising marginally, reaching maximum from the fourth to fifth quarter and then begin to experience marginal declines with increasing deviations. The response of output growth to a shock in inflation rate is very minimal; it starts to rise from the second quarter with positive marginal increases. The response of growth in output to a shock in interest rate and exchange rate seem similar, both started from the first quarter with negative responses and move towards zero from the seventh quarter. The response to interest rate is however larger than the exchange rate.

The inflation rate starts with a positive marginal response to a shock in growth in output from the first quarter to the third quarter and then assumes increasing negative responses from the third quarter onwards. The response of the inflation rate to a shock in itself starts with a very high positive response but with rapid decline to negative from the fifth quarter. Inflation shows a negative aggressive response to the interest rate only in the fifth quarter and remains negative thereafter. Response of inflation to a shock in exchange rate is very mild with both positive and negative responses, the negative response starting from the fifth quarter.

The interest rate has a positive fluctuating response to a shock in the inflation rates. The exchange rate does not however seem to respond strongly to shock in the inflation rate.

Apart from response to growth in ouput where both the the exchange rate and interst rate start from negative responses and move towards positve, the two variables generallly have positive responses to a shock in any of them, though with occasionally fluctuating trend.

Apart from the response of all the variables to growth rate of output which show increasing deviations, the other responses generally show mild deviations. Generally, a policy shock in any of the variables will have some level of effect on the other variables.

4.7 Summary of Results of Hypotheses Tests

The study tested five hypotheses. The summary results of the tests are outlined below. Decisions are made at 5% significance level.

The first hypothesis tested for the effect of inflation targeting on actual inflation. The study rejected the H_0 that inflation targeting has no effect on actual inflation base on the results in table 4.3. In table 4.3, the coefficient of the *InfTag* (-0.225) is statistically significant at 5%

level of significance. This means that inflation targeting has a significant negative effect on actual inflation.

The second hypothesis tested for the effect of inflation targeting on exchange rate. Base on the results presented in table 4.7, the study fails to reject H_0. The coefficient of the *InfTag* (-0.053) is not statistically significant at 5% level of statistical significance. This means that inflation targeting has no effect on exchange rate.

Thirdly, the study tested for the effect of inflation targeting on interest rate. From the results in table 4.6, the study rejects the H_0. The coefficient of the *InfTag* (-0.051) is statistically significant at 5% level of significance. This means inflation targeting has significant marginal negative effect on interest rate.

The fourth hypothesis tested for the effect of inflation targeting on growth rate of output. From the empirical results of 4.4, the study fails to reject the H_0. The coefficient of the *InfTag* (0.020) is not statistically significant at 5% level of significance. Therefore inflation targeting has no significant effect on growth rate on output.

Finally, the study tested for the hypothesis of tradeoff between inflation and growth of output. From the results of table 4.2, the study rejects the H_0. The negativity of the coefficient of lny_{t-1} (-0.225) indicates a tradeoff between inflation and growth rate of output. The coefficient is statistically significant at 5% level. This means disinflations will not negatively affect growth rate in output.

CHAPTER FIVE

CONCLUSION

5.1 Introduction

This chapter is the final chapter of the study. The first part of the chapter presents the summary of the major findings of the study. The second part presents the conclusions, recommendations and policy implications.

5.2 Summary of Major Findings

1. The study found that inflation targeting has a negative effect on actual inflation. From the results in table 4.2, the policy framework can reduce inflation about 22.5 percent. This means the policy has contributed to reduction in inflation over the years, and a continuation with the policy could eventually reduce inflations to the desired annual target levels of less than 10%.
2. Inflation targeting is also significant in reducing interest rates in Ghana. However this is minimal. From the results in table 4.6, the policy only has 5% significant negative effect on the interest rates. This explains why the interest rate has remained consistently high despite the implementation of the policy for over a decade now.
3. Inflation targeting does not however seem to have any effect on the exchange rates. From the results of the study (table 4.7), the policy has no significant effect on the exchange rate. The exchange rates has continued to deteriorate even after the implementation of the policy framework

4. The study also found that inflation targeting has no significant effect on the growth of output. From the results in table 4.4, the policy has no significant effect on the growth of output. The policy can therefore be implemented fully with disregard to the common argument that the policy could reduce the growth rate of output.

5. The findings on the tradeoff between inflation and output supports the above point that the inflation targeting will not affect the growth rate of output in Ghana. The results in table 4.2 indicate a negative relationship between inflation and growth of output. This means decrease in inflation can lead to increase in the growth rate of output. Overtime therefore, inflation targeting can contribute to growth rate of output in Ghana.

6. The study found one year lagged interest rate to negatively influence the actual inflation rate. However, one year lagged inflation rate does not significantly influence interest rate. This means increase in the interest rate could reduce the rate of inflation, but not vice versa.

7. There is high inertia in the price variables; inflation rate, interest rate and exchange rate. All these variables have high significant constants of 3.419, 0.522 and 0.439 for inflation rate, interest rate and exchange rate respectively. The exchange rate and interest rate also showed high persistence as indicated by the coefficient of their lagged values of 0.843 and 0.991 for the interest rates and exchange rates respectively.

8. Inflation targeting has increased the rate of adjustment of actual inflation to target inflation. Base on the resulted presented in equation 4.2 and 4.3, the rate of adjustment increase significantly from 25.9 percent in the non-targeting period to 76.5

percent in the targeting period. In other words, the framework has increased the rate of achieving the annual inflation target which reflected in significant reduction in the inflation gap.

9. One year lagged growth rate of output has significant positive effect on growth rate of output. From theoretical perspective, this is expected as previous year's growth rates in output could lead to increase in current growth rates through increase in consumption and investment.
10. The study found weak long run relationship among the variables. From the cointegration test, the study did not find any long run relationship between/among any of the variables. From the Granger causality test, the interest rate and inflation rate Granger causes each other. Exchange rate also Granger causes interest but not the opposite.

5.3 Recommendations and Policy Implications

From the findings of the study, the inflation targeting framework has been successful so far for the fight against inflation in Ghana. It has also been successful in reducing interest rate although this has been marginal. These successes also come at no cost in terms observable tradeoff between disinflation and growth rate in output.

The high inertia and persistence in inflation rate, exchange rate, and interest rate makes it difficult for the inflation targeting framework to significantly influence their reductions to levels that will be consistent for price stability. In this sense, credibility of the central bank is critically required to speed up the achievement of the price stability goal. Improving credibility will require higher degree of accountability and transparency of the central bank in the operation of the policy.

The inflation targeting framework barely has any effect on the exchange rate. Since exchange rate depreciation has been a bane of Ghana monetary policy, the Bank of Ghana can tackle this problem with the policy framework by directly or indirectly including the exchange rate as a target variable in the loss function to help curb the incessant disturbing trend of the depreciation of the Ghana cedi.

Even though the study did not find any significant trade-off between growth in output and disinflation, the long term growth policies of the government need to take into consideration the goal of the inflation targeting framework. As noted in the literature, the central bank cannot achieve sustainable growth in output in the long term as a result of constrains of expectations which can result into time inconsistent policies. The Bank can concentrate on its core mandate of price stability whilst synchronizing its objectives with the government in order to sustain its successes achieved so far with framework.

5.4 Limitation of the Study

The inflation targeting framework as well as the macroeconomy has broad issues. As such it is not possible for a study of this nature to fully cover the entire core issues in the framework and/or the macroeconomy.

On the side of the framework, the study was not able to cover the issues of implementation and operational challenges of the framework in Ghana. The study did not evaluate whether the Ghanaian economy is suitable or has met all the prerequisites of the inflation targeting framework before its adoption. Issues of credibility, accountability and transparency of the Bank of Ghana in the operations of the inflation targeting framework were not also covered by the study.

The study also focused on the monetary policy side of the economy. The fiscal side of the economy, such government expenditure and taxation which wasn't covered in the study, could also affect these variables.

The study measures the inflation targeting variable as a dummy at the expense of the actual targeted inflation rates. Even though the target values of inflation were used for the preliminary loss function, the same were not used for the VAR model.

5.5 Future Research Outlook

Future studies on the inflation targeting framework in Ghana can concentrate on the operational challenges and limitations of the framework which could deal with assessing the so-called prerequisites of the framework. The issues of credibility, transparency and accountability of the Bank of Ghana could also be a focus of future studies. Since these issues affect the success of the framework, there is the need to properly assess their effect in the operation of the framework in Ghana.

One other critical area that needs to be properly researched into is the transmission mechanisms of monetary policy in Ghana under the immediate past monetary policy and under the inflation targeting framework. Assessing the transmission mechanisms under the two alternative regimes will give underlining changes in the monetary policy transmission mechanisms under the inflation targeting framework if there has been, and possible modification of policy instruments.

Finally, the issue of methodological framework in assessing the effects of the inflation targeting framework has invoked debates among economists as assessment of the effect of the framework could be limited by the choice of an econometric model. This underlines why

the study has attempted to use alternative methodologies. The measurement of inflation targeting as a variable could also change. This topic can be further researched with different methodological approaches such as the structural autoregressive (SVAR) or the difference in difference (Ball and Sheridan, 2003) approaches for robust checking of the findings.

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APPENDIX A

REGRESSION RESULTS

Appendix A presents the results of the various regression results.

1. The Loss function

Regression results of equation 3.4.

$$i_t^* = \alpha + \gamma_\pi (\pi_t - \bar{\pi}_t) + \gamma_x x_t + \nu_t \qquad (3.4)$$

i_t is the policy rate =BRATE

$(\pi_t - \bar{\pi}_t)$ is the year-on-year inflation gap (actual inflation-target inflation)= YINFGAP

x_t is the real output growth gap (actual output - potential or target output)= RGDPGGAP

Dependent Variable: BRATE
Method: Least Squares
Date: 01/31/14 Time: 22:39
Sample: 2002:1 2011:4
Included observations: 40
BRATE=C(1)+C(2)*YINFGAP+C(3)*RGDGGAP

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	16.82302	0.783459	21.47274	0.0000
C(2)	0.135183	0.176131	0.767514	0.4476
C(3)	-1.166170	0.603719	-1.931643	0.0611

R-squared	0.101576	Mean dependent var	16.70000
Adjusted R-squared	0.053013	S.D. dependent var	3.870997
S.E. of regression	3.766 994	Akaike info criterion	5.562470
Sum squared resid	525.0389	Schwarz criterion	5.689136
Log likelihood	-108.2494	Durbin-Watson stat	0.117110

2. The SUR estimation results

The SUR estimation was done with the following equations;

$$ln\pi_t = \beta_0 + \beta_1 InfTag + \beta_2 lny_{t-1} + \beta_3 ln\pi_{t-1} + \beta_4 (lnr_{t-1} - ln\pi_{t-1}) + \mu_t$$

$$lny_t = \alpha_0 + \alpha_1 InfTag + \alpha_2 lny_{t-1} + \alpha_3 (lnr_{t-1} - ln\pi_{t-1}) + \alpha_4 lne_{t-1} + \varepsilon_t$$

$$lnr_t = \gamma_0 + \gamma_1 InfTag + \gamma_2 (lnr_{t-1} - ln\pi_{t-1}) + \gamma_3 ln\pi_{t-1} + \upsilon_t$$

$$lne_t = \lambda_0 + \lambda_1 InfTag + \lambda_2 lne_{t-1} + \lambda_3 (lnr_{t-1} - ln\pi_{t-1}) + \lambda_4 ln\pi_{t-1} + \sigma_t$$

Where;

$ln\pi_t$ is log of inflation rates (AYINF), and $ln\pi_{t-1}$is log of lag inflation rates (LN_LAYINF)

lny_t is log of growth rates of actual real GDP (AGDPGR), and $lny_{t-1}$is log of lag GDP growth rates (LN_LAGDPGR)

lnr_t is log of lending rates (INTRATE), and $lnr_{t-1}$is log of lag lending rates (LN_INTRATE)

lne_t log of exchange rates (EXCRATE), and $ln\pi_{t-1}$is log of lag exchange rates (LN_LEXCRATE)

$(lnr_{t-1} - ln\pi_{t-1})$ is log of lag real lending rates

InfTag is inflation targeting

System: FINAL
Estimation Method: Seemingly Unrelated Regression
Date: 01/31/14 Time: 18:51
Sample: 1992:2 2011:4
Included observations: 79
Total system (unbalanced) observations 310
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.419373	0.808164	4.231037	0.0000
C(2)	-0.225381	0.077254	-2.917418	0.0038
C(3)	0.157616	0.190161	0.828853	0.4079
C(4)	-0.596248	0.173126	-3.444005	0.0007
C(5)	-0.307656	0.150384	-2.045807	0.0417
C(6)	-0.053208	0.072362	-0.735305	0.4627
C(7)	0.020280	0.033328	0.608498	0.5433
C(8)	1.019650	0.045135	22.59117	0.0000
C(9)	0.039126	0.022214	1.761324	0.0792
C(10)	-0.009194	0.016044	-0.573040	0.5671
C(11)	0.522245	0.141398	3.693438	0.0003
C(12)	-0.050897	0.018247	-2.789383	0.0056
C(13)	0.843028	0.039802	21.18054	0.0000
C(14)	0.860848	0.039606	21.73517	0.0000
C(15)	0.438720	0.179411	2.445328	0.0151
C(16)	-0.052815	0.054734	-0.964941	0.3354
C(17)	0.991080	0.023700	41.81745	0.0000
C(18)	-0.111185	0.045799	-2.427645	0.0158
C(19)	-0.106404	0.046152	-2.305499	0.0218

Determinant residual covariance	1.28E-08

Equation: LN_AYINF=C(1)+C(2)*InfTag(3)*LN_LAYINF+C(4)
*(LN_LINTRATE-LN_LAYINF)+C(5)*LN_LAGDPGR
Observations: 76

R-squared	0.825236	Mean dependent var	2.932775
Adjusted R-squared	0.815390	S.D. dependent var	0.536224
S.E. of regression	0.230395	Sum squared resid	3.768819
Durbin-Watson stat	1.869825		

Equation: LN_AGDPGR=C(6)+C(7)*InfTag(8)*LN_LAGDPGR+C(9)
*(LN_LINTRATE-LN_LAYINF)+C(10)*LN_LEXCRATE

Observations: 76

R-squared	0.934648	Mean dependent var	1.641316
Adjusted R-squared	0.930966	S.D. dependent var	0.294288
S.E. of regression	0.077322	Sum squared resid	0.424491
Durbin-Watson stat	0.674416		

Equation: LN_INTRATE=C(11)+C(12)*InfTag(13)*(LN_LINTRATE -LN_LAYINF)+C(14)*LN_LAYINF

Observations: 79

R-squared	0.905199	Mean dependent var	3.489387
Adjusted R-squared	0.901407	S.D. dependent var	0.202951
S.E. of regression	0.063726	Sum squared resid	0.304572
Durbin-Watson stat	2.065130		

Equation: LN_EXCRATE=C(15)+C(16)*InfTag(17)*LN_LEXCRATE+C(18) *(LN_LINTRATE-LN_AYINF)+C(19)*LN_LAYINF

Observations: 79

R-squared	0.986881	Mean dependent var	-0.790600
Adjusted R-squared	0.986172	S.D. dependent var	1.085590
S.E. of regression	0.127656	Sum squared resid	1.205915
Durbin-Watson stat	2.292545		

3. The rate of Adjustment of Actual to Target inflation

i) Convergence for non targeting

The rates of adjustment was estimated with the following equation for non-targeting period

$$\Delta ln\pi^{*t} = b_1 + b_2 \Delta ln\pi^{*a} + b_3 t + \omega_{1t}$$

Where

$\Delta ln\pi^{*t}$ is the percentage change in the target inflation in the non targeting period (CTYINFIT)

$ln\pi^{*a}$ is the percentage change in actual inflation in the non-targeting period (CAYINFIT)

t is the trend factor

Dependent Variable: CTYINFIT
Method: Least Squares
Date: 01/31/14 Time: 21:51
Sample (adjusted): 1992:2 2001:4
Included observations: 39 after adjustments
CTYINFIT=C(1)+C(2)*CAYINFIT+C(3)*T

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.060124	0.099753	0.602734	0.5505
C(2)	0.259300	0.117464	2.207487	0.0337
C(3)	-0.000802	0.004315	-0.185935	0.8535

R-squared	0.121755	Mean dependent var	0.061231
Adjusted R-squared	0.072964	S.D. dependent var	0.314211
S.E. of regression	0.302531	Akaike info criterion	0.520536
Sum squared resid	3.294895	Schwarz criterion	0.648502
Log likelihood	-7.150450	Durbin-Watson stat	2.047930

ii) *Convergence for the targeting period*

Convergence during targeting period was estimated with the following equation

$$\Delta ln\pi^{it} = b_4 + b_5 \Delta ln\pi^{a} + b_6 t + \omega_{2t}$$

Where

$\Delta ln\pi^{it}$ is the percentage change in the target inflation in the targeting period (CNITYIN)

$ln\pi^{a}$ is the percentage change in actual inflation in the targeting period (CNIAYINF)

t is the trend factor

Dependent Variable: CNITTYINF
Method: Least Squares
Date: 01/31/14 Time: 22:04
Sample (adjusted): 2002:2 2011:4
Included observations: 39 after adjustments
CNITTYINF=C(1)+C(2)*CNITAYINF+C(3)*T

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.002561	0.059837	0.042793	0.9661
C(2)	0.765040	0.173132	4.418812	0.0001
C(3)	0.000408	0.002611	0.156400	0.8766

R-squared	0.353155	Mean dependent var	0.011754
Adjusted R-squared	0.317219	S.D. dependent var	0.220553
S.E. of regression	0.182244	Akaike info criterion	-0.493136
Sum squared resid	1.195665	Schwarz criterion	-0.365169
Log likelihood	12.61615	Durbin-Watson stat	2.008889

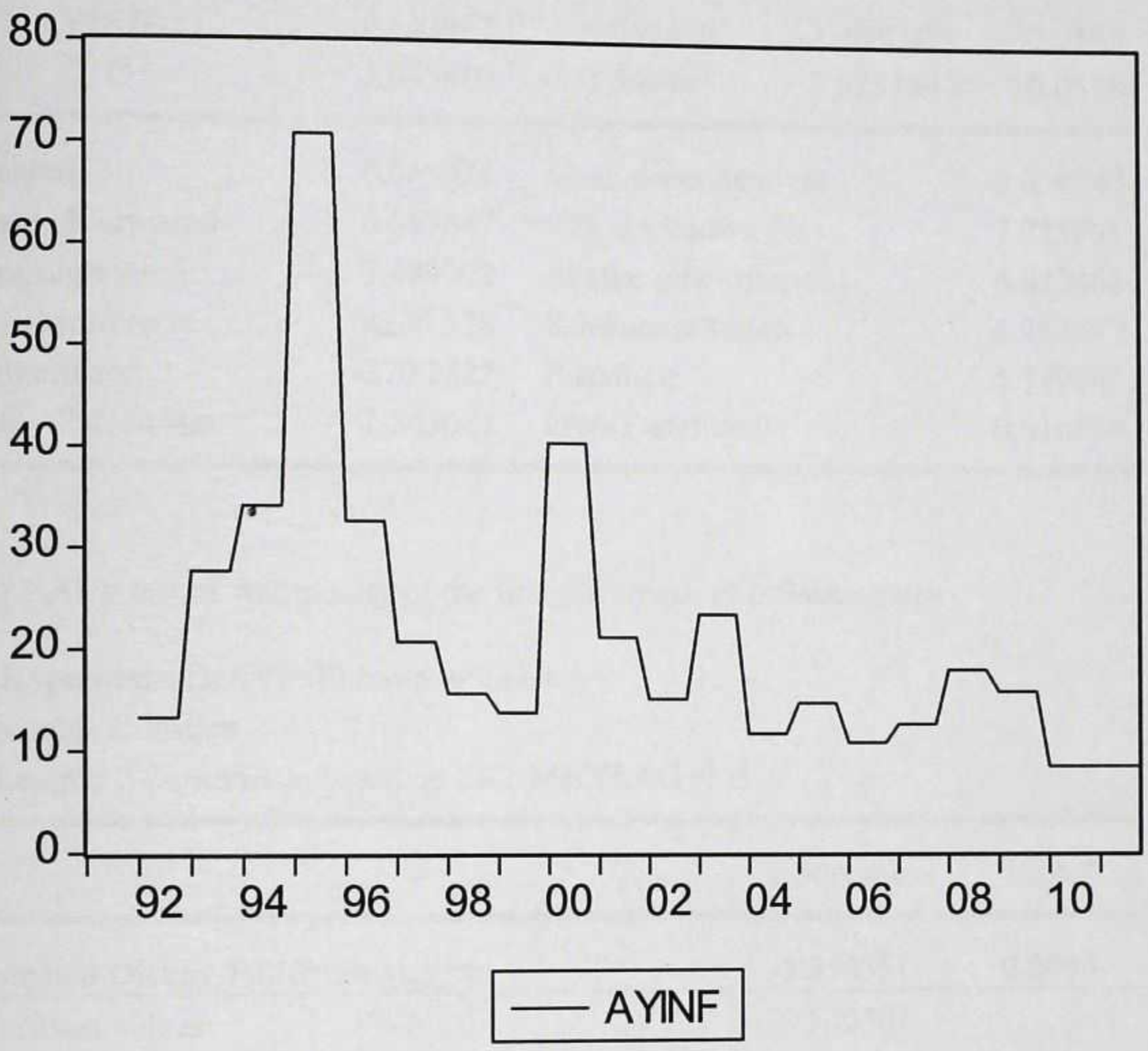
APPENDIX B

STATIONARITY TEST RESULTS

This section presents the graphical and ADF test of stationarity results for each variable.

1. **Test of stationarity of inflation rates (AYINF)**

a) Graphical plots of levels of inflation rates



b) ADF test of stationarity of levels of inflation rates

Null Hypothesis: AYINF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.406047	0.1434
Test critical values:	1% level	-3.515536	
	5% level	-2.898623	
	10% level	-2.586605	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AYINF)
Method: Least Squares
Date: 02/10/14 Time: 11:17
Sample (adjusted): 1992:2 2011:4
Included observations: 79 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AYINF(-1)	-0.142967	0.059420	-2.406047	0.0185
C	3.045610	1.541961	1.975154	0.0518

R-squared	0.069925	Mean dependent var	-0.059747
Adjusted R-squared	0.057847	S.D. dependent var	7.725991
S.E. of regression	7.499202	Akaike info criterion	6.892461
Sum squared resid	4330.328	Schwarz criterion	6.952447
Log likelihood	-270.2522	F-statistic	5.789061
Durbin-Watson stat	1.865023	Prob(F-statistic)	0.018524

c) ADF test of stationarity of the first difference of inflation rates

Null Hypothesis: D(AYINF) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.556551	0.0000
Test critical values:	1% level	-3.520307	
	5% level	-2.900670	
	10% level	-2.587691	

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

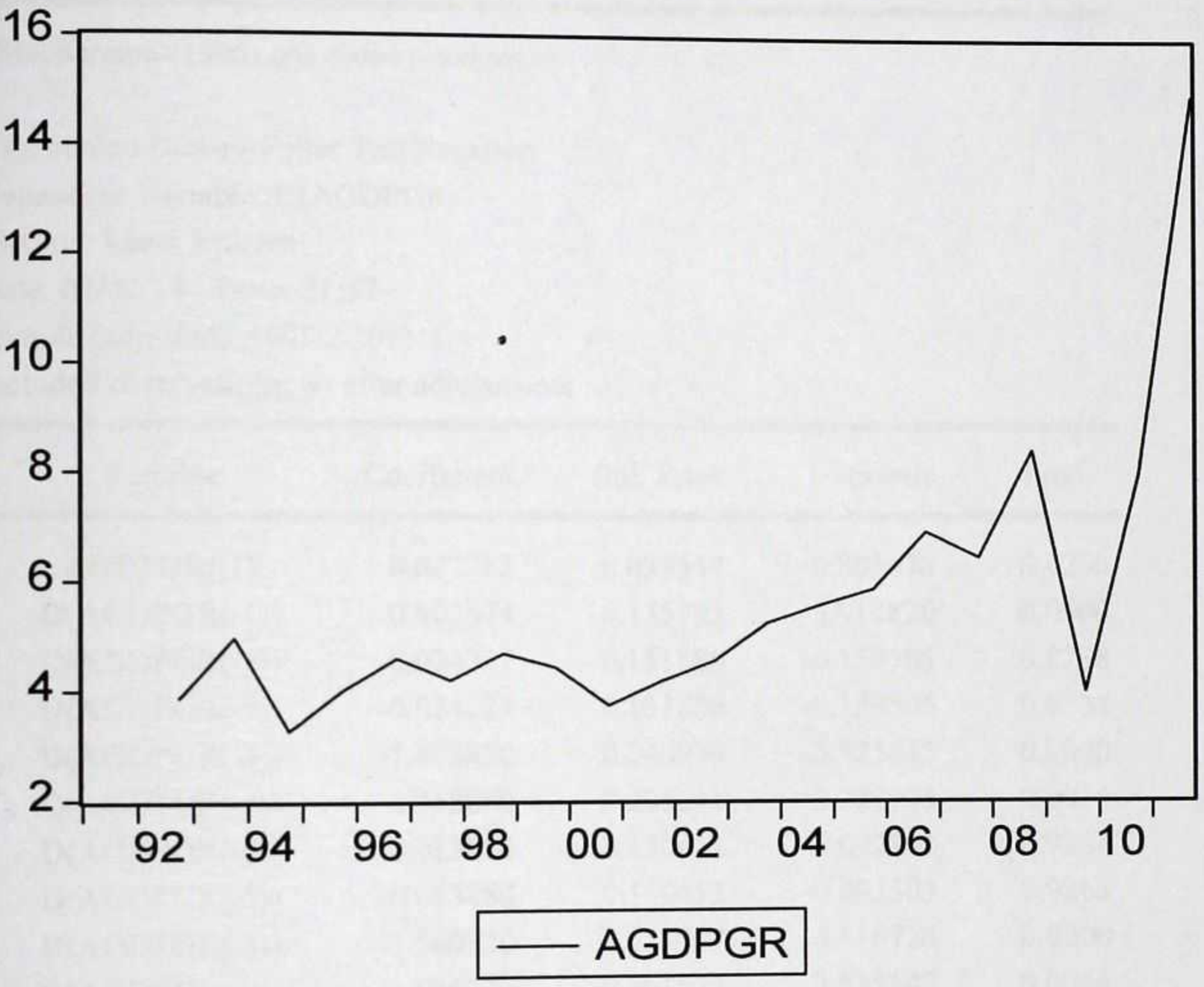
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AYINF,2)
Method: Least Squares
Date: 02/10/14 Time: 11:20
Sample (adjusted): 1993:2 2011:4
Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AYINF(-1))	-1.253613	0.225610	-5.556551	0.0000
D(AYINF(-1),2)	0.253339	0.195378	1.296661	0.1990
D(AYINF(-2),2)	0.253064	0.159520	1.586408	0.1172
D(AYINF(-3),2)	0.252789	0.112794	2.241157	0.0282
C	-0.270894	0.888817	-0.304781	0.7614

R-squared	0.544461	Mean dependent var	-0.192000
Adjusted R-squared	0.518430	S.D. dependent var	11.09067
S.E. of regression	7.696398	Akaike info criterion	6.983722
Sum squared resid	4146.418	Schwarz criterion	7.138222
Log likelihood	-256.8896	F-statistic	20.91604
Durbin-Watson stat	2.002104	Prob(F-statistic)	0.000000

2. Test of stationarity of growth rates of output

a) Graphical plot of levels of actual real GDP growth rates (AGDPGR)



b) ADF test of stationarity of the levels of GDP growth rates

Null Hypothesis: AGDPGR has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.803670	0.9934
Test critical values:	1% level	-3.531592	
	5% level	-2.905519	
	10% level	-2.590262	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AGDPGR)
Method: Least Squares
Date: 02/02/14 Time: 21:57
Sample (adjusted): 1995:2 2011:4
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGDPGR(-1)	0.027762	0.034544	0.803670	0.4250
D(AGDPGR(-1))	0.802874	0.135785	5.912820	0.0000
D(AGDPGR(-2))	-0.024227	0.151886	-0.159505	0.8738
D(AGDPGR(-3))	-0.024227	0.151886	-0.159505	0.8738
D(AGDPGR(-4))	-1.403420	0.240979	-5.823833	0.0000
D(AGDPGR(-5))	0.968680	0.291341	3.324904	0.0016
D(AGDPGR(-6))	-0.013884	0.150412	-0.092303	0.9268
D(AGDPGR(-7))	-0.013884	0.150412	-0.092303	0.9268
D(AGDPGR(-8))	-1.560220	0.323917	-4.816726	0.0000
D(AGDPGR(-9))	1.026246	0.361973	2.835147	0.0064
C	-0.073528	0.174009	-0.422555	0.6742

R-squared	0.788110	Mean dependent var	0.172276
Adjusted R-squared	0.750273	S.D. dependent var	0.566492
S.E. of regression	0.283091	Akaike info criterion	0.462924
Sum squared resid	4.487882	Schwarz criterion	0.824888
Log likelihood	-4.507941	F-statistic	20.82884
Durbin-Watson stat	1.898976	Prob(F-statistic)	0.000000

c) ADF test of stationarity of the first difference of GDP growth rates

Null Hypothesis: D(AGDPGR) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.352109	0.1592
Test critical values:	1% level	-3.531592	
	5% level	-2.905519	
	10% level	-2.590262	

*MacKinnon (1996) one-sided p-values

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AGDPGR,2)
Method: Least Squares
Date: 02/02/14 Time: 22:11
Sample (adjusted): 1995:2 2011:4
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGDPGR(-1))	-1.002597	0.426255	-2.352109	0.0221
D(AGDPGR(-1),2)	0.853430	0.380978	2.240101	0.0290
D(AGDPGR(-2),2)	0.853430	0.380978	2.240101	0.0290
D(AGDPGR(-3),2)	0.853430	0.380978	2.240101	0.0290
D(AGDPGR(-4),2)	-0.563710	0.401824	-1.402878	0.1661
D(AGDPGR(-5),2)	0.487076	0.234371	2.078228	0.0422
D(AGDPGR(-6),2)	0.487076	0.234371	2.078228	0.0422
D(AGDPGR(-7),2)	0.487076	0.234371	2.078228	0.0422
D(AGDPGR(-8),2)	-1.116041	0.343226	-3.251622	0.0019
C	0.062672	0.039348	1.592743	0.1167

R-squared	0.457325	Mean dependent var	0.023284
Adjusted R-squared	0.371639	S.D. dependent var	0.356015
S.E. of regression	0.282211	Akaike info criterion	0.444541
Sum squared resid	4.539644	Schwarz criterion	0.773599
Log likelihood	-4.892107	F-statistic	5.337240
Durbin-Watson stat	1.910914	Prob(F-statistic)	0.000028

d) ADF test of stationary of the second difference of actual real GDP growth rate

Null Hypothesis: D(AGDPGR,2) has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.462622	0.0000
Test critical values:	1% level	-3.531592	
	5% level	-2.905519	
	10% level	-2.590262	

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

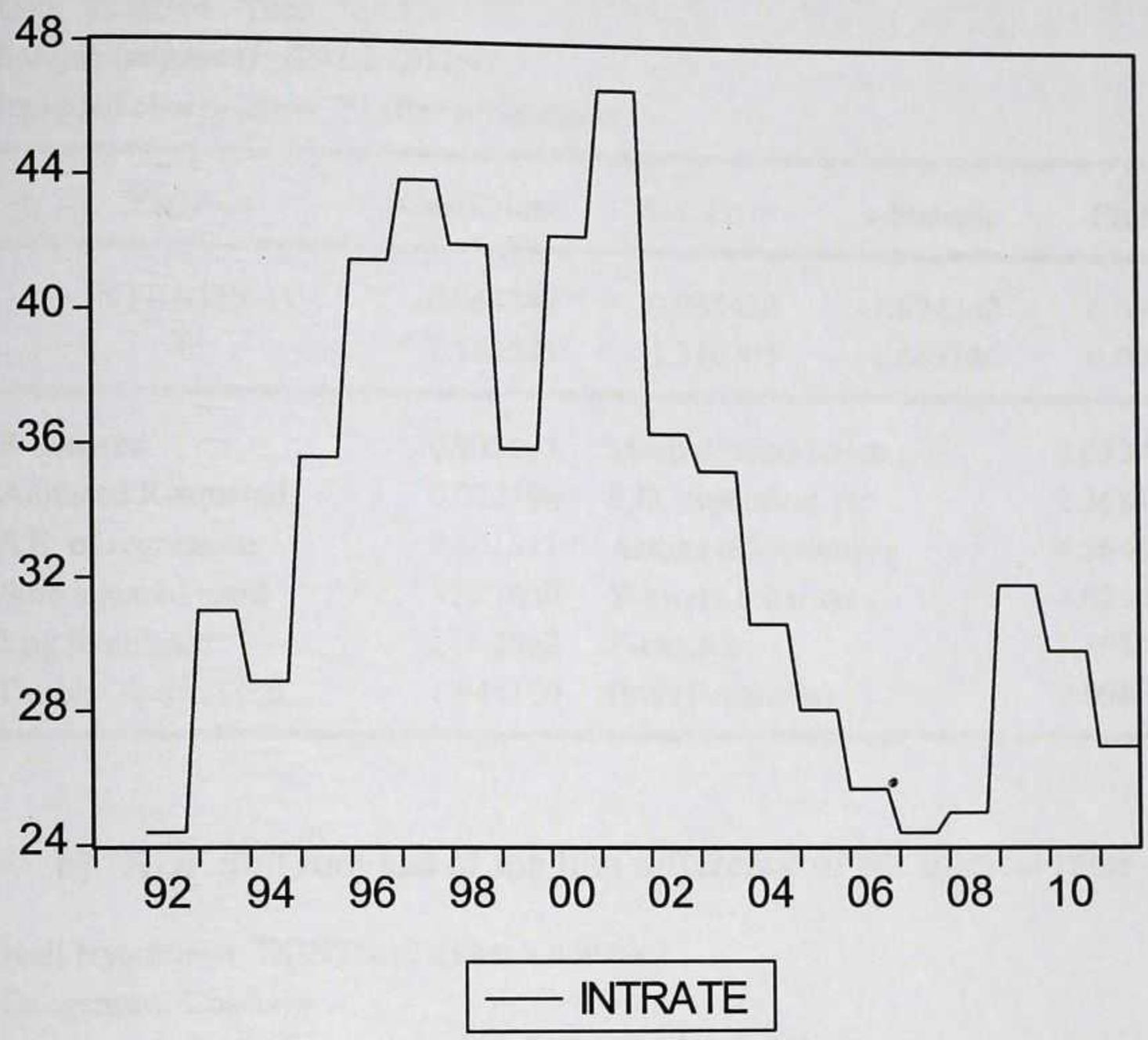
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AGDPGR,3)
Method: Least Squares
Date: 02/02/14 Time: 22:16
Sample (adjusted): 1995:2 2011:4
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGDPGR(-1),2)	-3.920923	0.606708	-6.462622	0.0000
D(AGDPGR(-1),3)	2.913384	0.587733	4.956984	0.0000
D(AGDPGR(-2),3)	2.905846	0.568404	5.112288	0.0000
D(AGDPGR(-3),3)	2.898308	0.548683	5.282298	0.0000
D(AGDPGR(-4),3)	1.533547	0.361934	4.237085	0.0001
D(AGDPGR(-5),3)	1.528525	0.344973	4.430858	0.0000
D(AGDPGR(-6),3)	1.523504	0.327348	4.654084	0.0000
D(AGDPGR(-7),3)	1.518483	0.308946	4.915045	0.0000
C	0.021977	0.036696	0.598906	0.5516

R-squared	0.709991	Mean dependent var	-0.009142
Adjusted R-squared	0.669990	S.D. dependent var	0.510092
S.E. of regression	0.293030	Akaike info criterion	0.507324
Sum squared resid	4.980262	Schwarz criterion	0.803476
Log likelihood	-7.995340	F-statistic	17.74926
Durbin-Watson stat	1.997311	Prob(F-statistic)	0.000000

3. Stationarity test of the interest rates (INTRATE)

Graphical plot of the levels of lending rates



a) ADF unit root test of the levels interest rates

Null Hypothesis: INTRATE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.674242	0.4403
Test critical values:	1% level	-3.515536	
	5% level	-2.898623	
	10% level	-2.586605	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTRATE)
Method: Least Squares
Date: 02/02/14 Time: 22:31
Sample (adjusted): 1992:2 2011:4
Included observations: 79 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INTRATE(-1)	-0.064342	0.038430	-1.674242	0.0981
C	2.182575	1.310709	1.665186	0.0999

R-squared	0.035125	Mean dependent var	0.032911
Adjusted R-squared	0.022594	S.D. dependent var	2.368421
S.E. of regression	2.341511	Akaike info criterion	4.564461
Sum squared resid	422.1660	Schwarz criterion	4.624447
Log likelihood	-178.2962	F-statistic	2.803087
Durbin-Watson stat	1.944110	Prob(F-statistic)	0.098141

b) ADF unit root test of the first difference of the interest rates

Null Hypothesis: D(INTRATE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.719525	0.0000
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTRATE,2)
Method: Least Squares
Date: 02/02/14 Time: 22:35
Sample (adjusted): 1992:3 2011:4
Included observations: 78 after adjustments

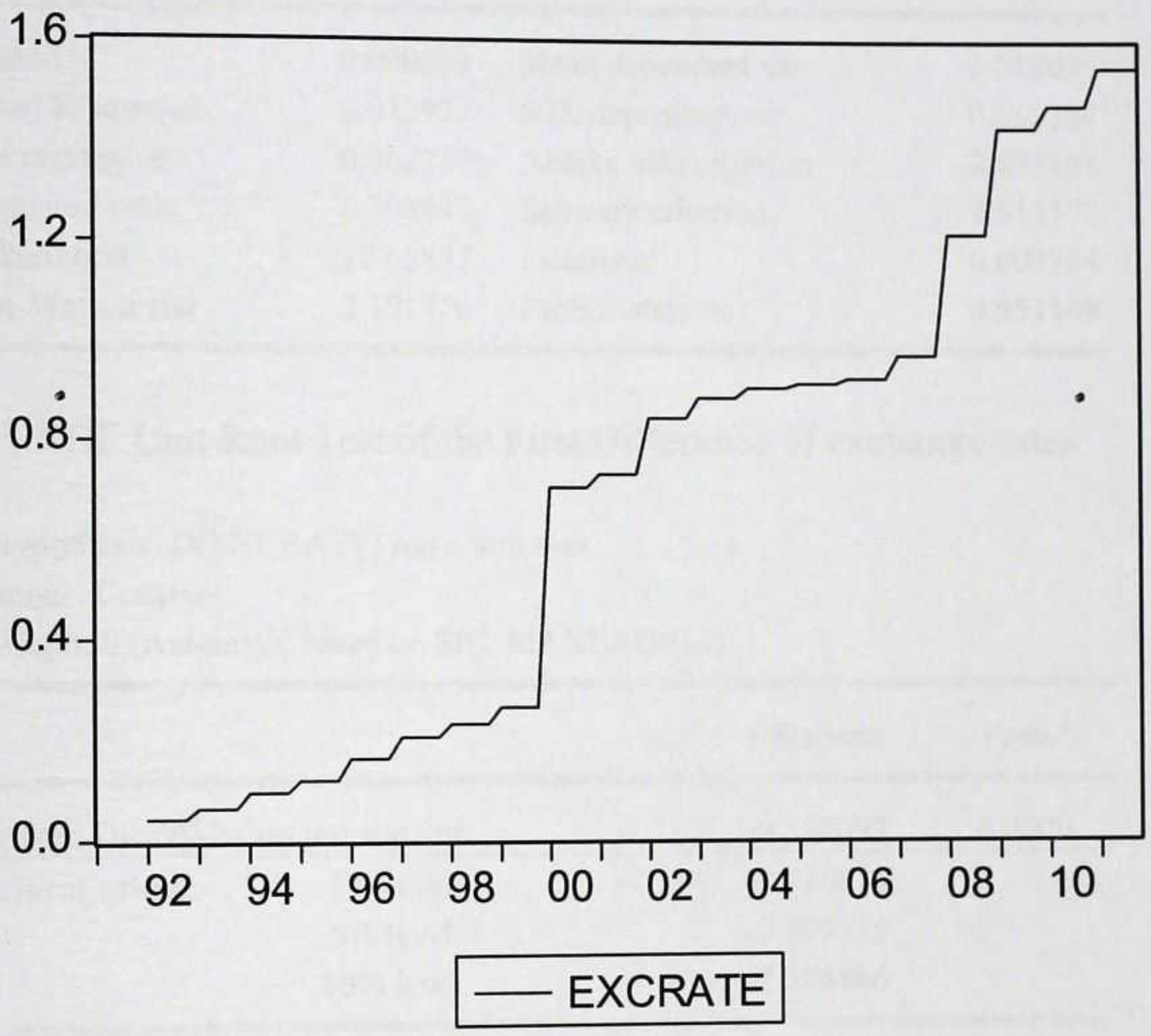
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INTRATE(-1))	-1.000198	0.114708	-8.719525	0.0000
C	0.033340	0.271703	0.122707	0.9027

R-squared	0.500099	Mean dependent var	8.99E-17
Adjusted R-squared	0.493521	S.D. dependent var	3.371462
S.E. of regression	2.399379	Akaike info criterion	4.613603

Sum squared resid	437.5333	Schwarz criterion	4.674032
Log likelihood	-177.9305	F-statistic	76.03011
Durbin-Watson stat	2.000000	Prob(F-statistic)	0.000000

4. Test of Stationarity of Exchange rates (EXCRATE)

a) Graphical plots of the levels of exchange rates



b) ADF Unit Root Test of Stationarity of levels of Exchange Rates

Null Hypothesis: EXCRATE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.061515	0.9607
Test critical values:	1% level	-3.515536	
	5% level	-2.898623	
	10% level	-2.586605	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCRATE)
Method: Least Squares
Date: 02/02/14 Time: 22:44
Sample (adjusted): 1992:2 2011:4
Included observations: 79 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCRATE(-1)	0.000894	0.014529	0.061515	0.9511
C	0.018469	0.012095	1.527002	0.1309

R-squared	0.000049	Mean dependent var	0.019073
Adjusted R-squared	-0.012937	S.D. dependent var	0.062384
S.E. of regression	0.062787	Akaike info criterion	-2.673158
Sum squared resid	0.303547	Schwarz criterion	-2.613172
Log likelihood	107.5897	F-statistic	0.003784
Durbin-Watson stat	2.191416	Prob(F-statistic)	0.951109

c) ADF Unit Root Test of the First Difference of exchange rates

Null Hypothesis: D(EXCRATE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.599097	0.0000
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCRATE,2)
Method: Least Squares
Date: 02/02/14 Time: 22:44
Sample (adjusted): 1992:3 2011:4
Included observations: 78 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXCRATE(-1))	-1.096006	0.114178	-9.599097	0.0000
C	0.021173	0.007452	2.841009	0.0058

R-squared	0.548003	Mean dependent var	0.000000
Adjusted R-squared	0.542056	S.D. dependent var	0.092904
S.E. of regression	0.062870	Akaike info criterion	-2.670195
Sum squared resid	0.300399	Schwarz criterion	-2.609766

Log likelihood	106.1376	F-statistic	92.14266
Durbin-Watson stat	2.020392	Prob(F-statistic)	0.000000

APPENDIX C

THE LONG RUN ANALYSIS

This section presents the results of the various long run estimations.

1. Lag selection criteria test

VAR Lag Order Selection Criteria
Endogenous variables: AGDPGR AYINF INTRATE EXCRATE
Exogenous variables: C
Date: 02/03/14 Time: 13:04
Sample: 1991:1 2011:4
Included observations: 70

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-663.6889	NA	2264.989	19.07683	19.20531	19.12786
1	-340.7833	599.6819	0.352593	10.30809	10.95052*	10.56327
2	-309.3357	54.80868	0.227854	9.866734	11.02310	10.32606*
3	-302.8214	10.60905	0.302307	10.13775	11.80806	10.80122
4	-286.5499	24.63968	0.306694	10.13000	12.31425	10.99761
5	-254.2474	45.22338*	0.199660*	9.664213*	12.36241	10.73597
6	-242.9205	14.56323	0.241215	9.797728	13.00986	11.07363
7	-234.1888	10.22858	0.321676	10.00539	13.73147	11.48544

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

2. Johansen Cointegration Test

Date: 02/03/14 Time: 18:46
Sample (adjusted): 1994:2 2011:4
Included observations: 71 after adjustments
Trend assumption: Linear deterministic trend
Series: AGDPGR AYINF EXCRATE INTRATE InfTag
Lags interval (in first differences): 1 to 5

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value
None	0.305448	66.46423	69.81889
At most 1	0.290921	40.58557	47.85613
At most 2	0.153190	16.17662	29.79707
At most 3	0.031164	4.370815	15.49471
At most 4	0.029458	2.122928	3.841466

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value
None	0.305448	25.87866	33.87687
At most 1	0.290921	24.40895	27.58434
At most 2	0.153190	11.80581	21.13162
At most 3	0.031164	2.247887	14.26460
At most 4	0.029458	2.122928	3.841466

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

AGDPGR	AYINF	EXCRATE	INTRATE
1.532109	0.055700	-7.394353	0.223572
0.153159	0.121556	1.665039	-0.194884
-0.706185	0.188429	3.488389	0.092983
-1.986404	-0.149453	-1.942663	-0.138703
-2.164238	-0.239100	-3.024020	-0.392944

Unrestricted Adjustment Coefficients (alpha):

D(AGDPGR)	-0.114497	-0.038361	0.014952	-0.027723	0.024086
D(AYINF)	-1.409858	1.607260	-0.727374	0.148011	0.123334
D(EXCRATE)	-0.003983	0.006075	-0.009182	-0.004987	-0.006552
D(INTRATE)	0.344650	1.003940	-0.105099	-0.081413	0.000959
D(InfTag)	-0.035274	-0.011982	-2.09E-05	0.007449	-0.011788

1 Cointegrating Equation(s): Log likelihood -126.2683

Normalized cointegrating coefficients (standard error in parentheses)

AGDPGR	AYINF	EXCRATE	INTRATE	IT
1.000000	0.036355	-4.826257	0.145924	4.001986
	(0.04178)	(1.34101)	(0.04838)	(1.07688)

Adjustment coefficients (standard error in parentheses)

D(AGDPGR)	-0.175422
	(0.06561)
D(AYINF)	-2.160056
	(0.98191)
D(EXCRATE)	-0.006102
	(0.01258)
D(INTRATE)	0.528041
	(0.46307)
D(InfTag)	-0.054043
	(0.02289)

2 Cointegrating Equation(s): Log likelihood -114.0639

Normalized cointegrating coefficients (standard error in parentheses)

AGDPGR	AYINF	EXCRATE	INTRATE	IT
1.000000	0.000000	-5.579831	0.214013	5.173743
		(1.17086)	(0.05360)	(1.24333)
0.000000	1.000000	20.72822	-1.872896	-32.23100
		(13.8685)	(0.63487)	(14.7269)

Adjustment coefficients (standard error in parentheses)

D(AGDPGR)	-0.181297	-0.011040
	(0.06533)	(0.00567)
D(AYINF)	-1.913889	0.116843
	(0.91356)	(0.07933)
D(EXCRATE)	-0.005171	0.000517
	(0.01257)	(0.00109)
D(INTRATE)	0.681804	0.141232
	(0.40282)	(0.03498)
D(InfTag)	-0.055878	-0.003421
	(0.02283)	(0.00198)

3 Cointegrating Equation(s): Log likelihood -108.1610

Normalized cointegrating coefficients (standard error in parentheses)

AGDPGR	AYINF	EXCRATE	INTRATE	IT
1.000000	0.000000	0.000000	-0.550431	-10.25779
			(0.20289)	(2.60043)
0.000000	1.000000	0.000000	0.966899	25.09478
			(0.53827)	(6.89903)
0.000000	0.000000	1.000000	-0.137001	-2.765591
			(0.04069)	(0.52149)

Adjustment coefficients (standard error in parentheses)

D(AGDPGR)	-0.191856	-0.008223	0.834915
	(0.07177)	(0.00979)	(0.35351)
D(AYINF)	-1.400229	-0.020215	10.56377
	(0.98775)	(0.13472)	(4.86521)
D(EXCRATE)	0.001313	-0.001214	0.007533
	(0.01363)	(0.00186)	(0.06712)
D(INTRATE)	0.756023	0.121428	-1.243488
	(0.44236)	(0.06034)	(2.17886)
D(InfTag)	-0.055863	-0.003425	0.240802
	(0.02512)	(0.00343)	(0.12374)

4 Cointegrating Equation(s): Log likelihood -107.0370

Normalized cointegrating coefficients (standard error in parentheses)

AGDPGR	AYINF	EXCRATE	INTRATE	IT
1.000000	0.000000	0.000000	0.000000	-1.529504
				(0.86095)
0.000000	1.000000	0.000000	0.000000	9.762495
				(3.67038)
0.000000	0.000000	1.000000	0.000000	-0.593137
				(0.21507)
0.000000	0.000000	0.000000	1.000000	15.85717
				(2.85369)

Adjustment coefficients (standard error in parentheses)

D(AGDPGR)	-0.136787	-0.004080	0.888771	-0.012887
	(0.11007)	(0.01160)	(0.36120)	(0.01435)
D(AYINF)	-1.694239	-0.042335	10.27624	-0.716596
	(1.52113)	(0.16033)	(4.99168)	(0.19832)
D(EXCRAT)	0.011218	-0.000468	0.017221	-0.002236
	(0.02091)	(0.00220)	(0.06862)	(0.00273)
D(INTRATE)	0.917741	0.133596	-1.085331	-0.117078
	(0.68098)	(0.07178)	(2.23466)	(0.08878)
D(InfTag)	-0.070661	-0.004538	0.226330	-0.006586
	(0.03860)	(0.00407)	(0.12668)	(0.00503)

3. VAR estimation results

Vector Autoregression Estimates
Date: 03/26/14 Time: 11:33
Sample (adjusted): 1994:1 2011:4
Included observations: 72 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	AGDPGR	AYINF	INTRATE	EXCRATE
AGDPGR(-1)	1.761221	0.533835	0.362399	0.007761
	(0.14126)	(2.47676)	(0.83035)	(0.02563)
	[12.4679]	[0.21554]	[0.43644]	[0.30278]
AGDPGR(-2)	-0.733792	-0.784078	0.002433	-0.005895
	(0.28651)	(5.02341)	(1.68413)	(0.05199)
	[-2.56116]	[-0.15608]	[0.00144]	[-0.11339]
AGDPGR(-3)	-6.57E-13	-5.33E-13	2.33E-13	-1.69E-14
	(0.30320)	(5.31601)	(1.78223)	(0.05502)
	[-2.2e-12]	[-1.0e-13]	[1.3e-13]	[-3.1e-13]
AGDPGR(-4)	-0.243624	-3.682864	-0.642667	0.001466
	(0.29120)	(5.10563)	(1.71170)	(0.05284)
	[-0.83663]	[-0.72133]	[-0.37546]	[0.02774]
AGDPGR(-5)	0.293417	3.228596	1.304951	0.001922
	(0.17472)	(3.06339)	(1.02702)	(0.03170)
	[1.67937]	[1.05393]	[1.27061]	[0.06061]
AYINF(-1)	0.005794	0.744360	0.024059	-0.000565
	(0.00766)	(0.13430)	(0.04503)	(0.00139)
	[0.75639]	[5.54244]	[0.53434]	[-0.40660]
AYINF(-2)	0.000263	-0.002395	0.003492	1.79E-05
	(0.00818)	(0.14343)	(0.04809)	(0.00148)
	[0.03209]	[-0.01670]	[0.07261]	[0.01203]
AYINF(-3)	0.000263	-0.002395	0.003492	1.79E-05
	(0.00818)	(0.14343)	(0.04809)	(0.00148)
	[0.03209]	[-0.01670]	[0.07261]	[0.01203]
AYINF(-4)	-0.002117	-0.139258	0.121114	-0.001049
	(0.00815)	(0.14297)	(0.04793)	(0.00148)
	[-0.25960]	[-0.97407]	[2.52688]	[-0.70922]
AYINF(-5)	0.003020	0.091884	-0.051784	0.000326
	(0.00663)	(0.11616)	(0.03894)	(0.00120)
	[0.45586]	[0.79099]	[-1.32968]	[0.27082]

INTRATE(-1)	-0.007334	0.099089	0.731852	0.002068
	(0.02390)	(0.41908)	(0.14050)	(0.00434)
	[-0.30683]	[0.23644]	[5.20888]	[0.47682]
INTRATE(-2)	0.001670	-0.015234	0.022209	0.000114
	(0.02795)	(0.49011)	(0.16431)	(0.00507)
	[0.05973]	[-0.03108]	[0.13516]	[0.02240]
INTRATE(-3)	0.001670	-0.015234	0.022209	0.000114
	(0.02795)	(0.49011)	(0.16431)	(0.00507)
	[0.05973]	[-0.03108]	[0.13516]	[0.02240]
INTRATE(-4)	0.017823	-1.922913	-0.090334	-0.008960
	(0.02746)	(0.48147)	(0.16142)	(0.00498)
	[0.64903]	[-3.99383]	[-0.55963]	[-1.79821]
INTRATE(-5)	0.000332	1.404001	0.261340	0.006006
	(0.02258)	(0.39590)	(0.13273)	(0.00410)
	[0.01470]	[3.54636]	[1.96899]	[1.46577]
EXCRATE(-1)	-0.345895	2.950653	5.021823	0.876576
	(0.79297)	(13.9034)	(4.66122)	(0.14389)
	[-0.43620]	[0.21222]	[1.07736]	[6.09206]
EXCRATE(-2)	-0.040952	0.373606	-0.544686	-0.002786
	(0.97179)	(17.0386)	(5.71232)	(0.17633)
	[-0.04214]	[0.02193]	[-0.09535]	[-0.01580]
EXCRATE(-3)	-0.040952	0.373606	-0.544686	-0.002786
	(0.97179)	(17.0386)	(5.71232)	(0.17633)
	[-0.04214]	[0.02193]	[-0.09535]	[-0.01580]
EXCRATE(-4)	0.479482	-8.824852	5.767379	0.492958
	(0.98134)	(17.2061)	(5.76846)	(0.17807)
	[0.48860]	[-0.51289]	[0.99981]	[2.76838]
EXCRATE(-5)	0.256644	-3.912680	-11.78139	-0.408951
	(0.83010)	(14.5543)	(4.87944)	(0.15062)
	[0.30917]	[-0.26883]	[-2.41450]	[-2.71504]
C	-1.155576	31.59718	-4.899201	0.074174
	(0.99686)	(17.4782)	(5.85969)	(0.18088)
	[-1.15922]	[1.80780]	[-0.83608]	[0.41006]
R-squared	0.977894	0.862835	0.928592	0.985495
Adj. R-squared	0.969225	0.809045	0.900589	0.979807
Sum sq. resids	6.993547	2149.922	241.6454	0.230265
S.E. equation	0.370308	6.492714	2.176728	0.067194
F-statistic	112.8033	16.04079	33.16036	173.2529
Log likelihood	-18.22315	-224.4383	-145.7526	104.6632
Akaike AIC	1.089532	6.817731	4.632016	-2.323978

Schwarz SC	1.753560	7.481759	5.296043	-1.659951
Mean dependent	5.524375	21.67389	33.95556	0.756956
S.D. dependent	2.110885	14.85802	6.903783	0.472855

Determinant resid covariance (dof adj.)	0.086651
Determinant resid covariance	0.021813
Log likelihood	-270.9459
Akaike information criterion	9.859608
Schwarz criterion	12.51572

4. VAR estimation for P-value

System: UNTITLED
Estimation Method: Least Squares
Date: 03/26/14 Time: 17:07
Sample: 1994:1 2011:4
Included observations: 72
Total system (balanced) observations 288

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.761221	0.141261	12.46786	0.0000
C(2)	-0.733792	0.286507	-2.561160	0.0112
C(3)	-3.85E-12	0.303196	-1.27E-11	1.0000
C(4)	-0.243624	0.291197	-0.836630	0.4038
C(5)	0.293417	0.174719	1.679368	0.0946
C(6)	0.005794	0.007660	0.756391	0.4503
C(7)	0.000263	0.008181	0.032091	0.9744
C(8)	0.000263	0.008181	0.032091	0.9744
C(9)	-0.002117	0.008154	-0.259602	0.7954
C(10)	0.003020	0.006625	0.455857	0.6490
C(11)	-0.007334	0.023902	-0.306831	0.7593
C(12)	0.001670	0.027953	0.059735	0.9524
C(13)	0.001670	0.027953	0.059735	0.9524
C(14)	0.017823	0.027460	0.649029	0.5170
C(15)	0.000332	0.022580	0.014701	0.9883
C(16)	-0.345895	0.792975	-0.436199	0.6632
C(17)	-0.040952	0.971789	-0.042141	0.9664
C(18)	-0.040952	0.971789	-0.042141	0.9664
C(19)	0.479482	0.981340	0.488599	0.6257
C(20)	0.256644	0.830098	0.309173	0.7575
C(21)	-1.155576	0.996860	-1.159216	0.2477
C(22)	0.533835	2.476764	0.215537	0.8296
C(23)	-0.784078	5.023409	-0.156085	0.8761
C(24)	-6.78E-12	5.316009	-1.28E-12	1.0000
C(25)	-3.682864	5.105630	-0.721334	0.4715
C(26)	3.228596	3.063393	1.053928	0.2932
C(27)	0.744360	0.134302	5.542436	0.0000
C(28)	-0.002395	0.143433	-0.016698	0.9867

C(29)	-0.002395	0.143433	-0.016698	0.9867
C(30)	-0.139258	0.142965	-0.974070	0.3312
C(31)	0.091884	0.116164	0.790987	0.4299
C(32)	0.099089	0.419084	0.236443	0.8133
C(33)	-0.015234	0.490113	-0.031082	0.9752
C(34)	-0.015234	0.490113	-0.031082	0.9752
C(35)	-1.922913	0.481471	-3.993833	0.0001
C(36)	1.404001	0.395899	3.546358	0.0005
C(37)	2.950653	13.90343	0.212225	0.8321
C(38)	0.373606	17.03863	0.021927	0.9825
C(39)	0.373606	17.03863	0.021927	0.9825
C(40)	-8.824852	17.20608	-0.512891	0.6086
C(41)	-3.912680	14.55432	-0.268833	0.7883
C(42)	31.59718	17.47821	1.807804	0.0721
C(43)	0.362399	0.830353	0.436439	0.6630
C(44)	0.002433	1.684133	0.001445	0.9988
C(45)	3.62E-11	1.782229	2.03E-11	1.0000
C(46)	-0.642667	1.711698	-0.375456	0.7077
C(47)	1.304951	1.027024	1.270613	0.2053
C(48)	0.024059	0.045026	0.534340	0.5937
C(49)	0.003492	0.048087	0.072613	0.9422
C(50)	0.003492	0.048087	0.072613	0.9422
C(51)	0.121114	0.047930	2.526879	0.0123
C(52)	-0.051784	0.038945	-1.329678	0.1851
C(53)	0.731852	0.140501	5.208880	0.0000
C(54)	0.022209	0.164314	0.135163	0.8926
C(55)	0.022209	0.164314	0.135163	0.8926
C(56)	-0.090334	0.161416	-0.559633	0.5763
C(57)	0.261340	0.132728	1.968990	0.0503
C(58)	5.021823	4.661222	1.077362	0.2826
C(59)	-0.544686	5.712322	-0.095353	0.9241
C(60)	-0.544686	5.712322	-0.095353	0.9241
C(61)	5.767379	5.768460	0.999813	0.3186
C(62)	-11.78139	4.879439	-2.414498	0.0166
C(63)	-4.899201	5.859693	-0.836085	0.4041
C(64)	0.007761	0.025632	0.302779	0.7624
C(65)	-0.005895	0.051988	-0.113389	0.9098
C(66)	-5.60E-12	0.055016	-1.02E-10	1.0000
C(67)	0.001466	0.052839	0.027742	0.9779
C(68)	0.001922	0.031703	0.060614	0.9517
C(69)	-0.000565	0.001390	-0.406603	0.6847
C(70)	1.79E-05	0.001484	0.012032	0.9904
C(71)	1.79E-05	0.001484	0.012032	0.9904
C(72)	-0.001049	0.001480	-0.709225	0.4790
C(73)	0.000326	0.001202	0.270817	0.7868
C(74)	0.002068	0.004337	0.476816	0.6340
C(75)	0.000114	0.005072	0.022396	0.9822
C(76)	0.000114	0.005072	0.022396	0.9822
C(77)	-0.008960	0.004983	-1.798209	0.0736
C(78)	0.006006	0.004097	1.465775	0.1442
C(79)	0.876576	0.143888	6.092064	0.0000

C(80)	-0.002786	0.176335	-0.015800	0.9874
C(81)	-0.002786	0.176335	-0.015800	0.9874
C(82)	0.492958	0.178068	2.768377	0.0062
C(83)	-0.408951	0.150624	-2.715038	0.0072
C(84)	0.074174	0.180884	0.410063	0.6822

Determinant residual covariance 0.021813

Equation: AGDPGR = C(1)*AGDPGR(-1) + C(2)*AGDPGR(-2) + C(3)
*AGDPGR(-3) + C(4)*AGDPGR(-4) + C(5)*AGDPGR(-5) + C(6)
*AYINF(-1) + C(7)*AYINF(-2) + C(8)*AYINF(-3) + C(9)*AYINF(-4) +
C(10)*AYINF(-5) + C(11)*INTRATE(-1) + C(12)*INTRATE(-2) +
C(13)*INTRATE(-3) + C(14)*INTRATE(-4) + C(15)*INTRATE(-5) +
C(16)*EXCRATE(-1) + C(17)*EXCRATE(-2) + C(18)*EXCRATE(-3)
+ C(19)*EXCRATE(-4) + C(20)*EXCRATE(-5) + C(21)

Observations: 72

R-squared	0.977894	Mean dependent var	5.524375
Adjusted R-squared	0.969225	S.D. dependent var	2.110885
S.E. of regression	0.370308	Sum squared resid	6.993546
Durbin-Watson stat	1.823010		

Equation: AYINF = C(22)*AGDPGR(-1) + C(23)*AGDPGR(-2) + C(24)
*AGDPGR(-3) + C(25)*AGDPGR(-4) + C(26)*AGDPGR(-5) +
C(27)*AYINF(-1) + C(28)*AYINF(-2) + C(29)*AYINF(-3) + C(30)
*AYINF(-4) + C(31)*AYINF(-5) + C(32)*INTRATE(-1) + C(33)
*INTRATE(-2) + C(34)*INTRATE(-3) + C(35)*INTRATE(-4) + C(36)
*INTRATE(-5) + C(37)*EXCRATE(-1) + C(38)*EXCRATE(-2) +
C(39)*EXCRATE(-3) + C(40)*EXCRATE(-4) + C(41)*EXCRATE(-5)
+ C(42)

Observations: 72

R-squared	0.862835	Mean dependent var	21.67389
Adjusted R-squared	0.809045	S.D. dependent var	14.85802
S.E. of regression	6.492714	Sum squared resid	2149.922
Durbin-Watson stat	1.713529		

Equation: INTRATE = C(43)*AGDPGR(-1) + C(44)*AGDPGR(-2) +
C(45)*AGDPGR(-3) + C(46)*AGDPGR(-4) + C(47)*AGDPGR(-5) +
C(48)*AYINF(-1) + C(49)*AYINF(-2) + C(50)*AYINF(-3) + C(51)
*AYINF(-4) + C(52)*AYINF(-5) + C(53)*INTRATE(-1) + C(54)
*INTRATE(-2) + C(55)*INTRATE(-3) + C(56)*INTRATE(-4) + C(57)
*INTRATE(-5) + C(58)*EXCRATE(-1) + C(59)*EXCRATE(-2) +
C(60)*EXCRATE(-3) + C(61)*EXCRATE(-4) + C(62)*EXCRATE(-5)
+ C(63)

Observations: 72

R-squared	0.928592	Mean dependent var	33.95555
Adjusted R-squared	0.900589	S.D. dependent var	6.903783
S.E. of regression	2.176728	Sum squared resid	241.6454
Durbin-Watson stat	2.105870		

Equation: EXCRATE = C(64)*AGDPGR(-1) + C(65)*AGDPGR(-2) +
C(66)*AGDPGR(-3) + C(67)*AGDPGR(-4) + C(68)*AGDPGR(-5) +

C(69)*AYINF(-1) + C(70)*AYINF(-2) + C(71)*AYINF(-3) + C(72)
*AYINF(-4) + C(73)*AYINF(-5) + C(74)*INTRATE(-1) + C(75)
*INTRATE(-2) + C(76)*INTRATE(-3) + C(77)*INTRATE(-4) + C(78)
*INTRATE(-5) + C(79)*EXCRATE(-1) + C(80)*EXCRATE(-2) +
C(81)*EXCRATE(-3) + C(82)*EXCRATE(-4) + C(83)*EXCRATE(-5)
+ C(84)

Observations: 72

R-squared	0.985495	Mean dependent var	0.756956
Adjusted R-squared	0.979807	S.D. dependent var	0.472855
S.E. of regression	0.067194	Sum squared resid	0.230265
Durbin-Watson stat	1.957014		

4. Residual plots of the levels of inflation Interest, exchange rates and GDP growth rates