

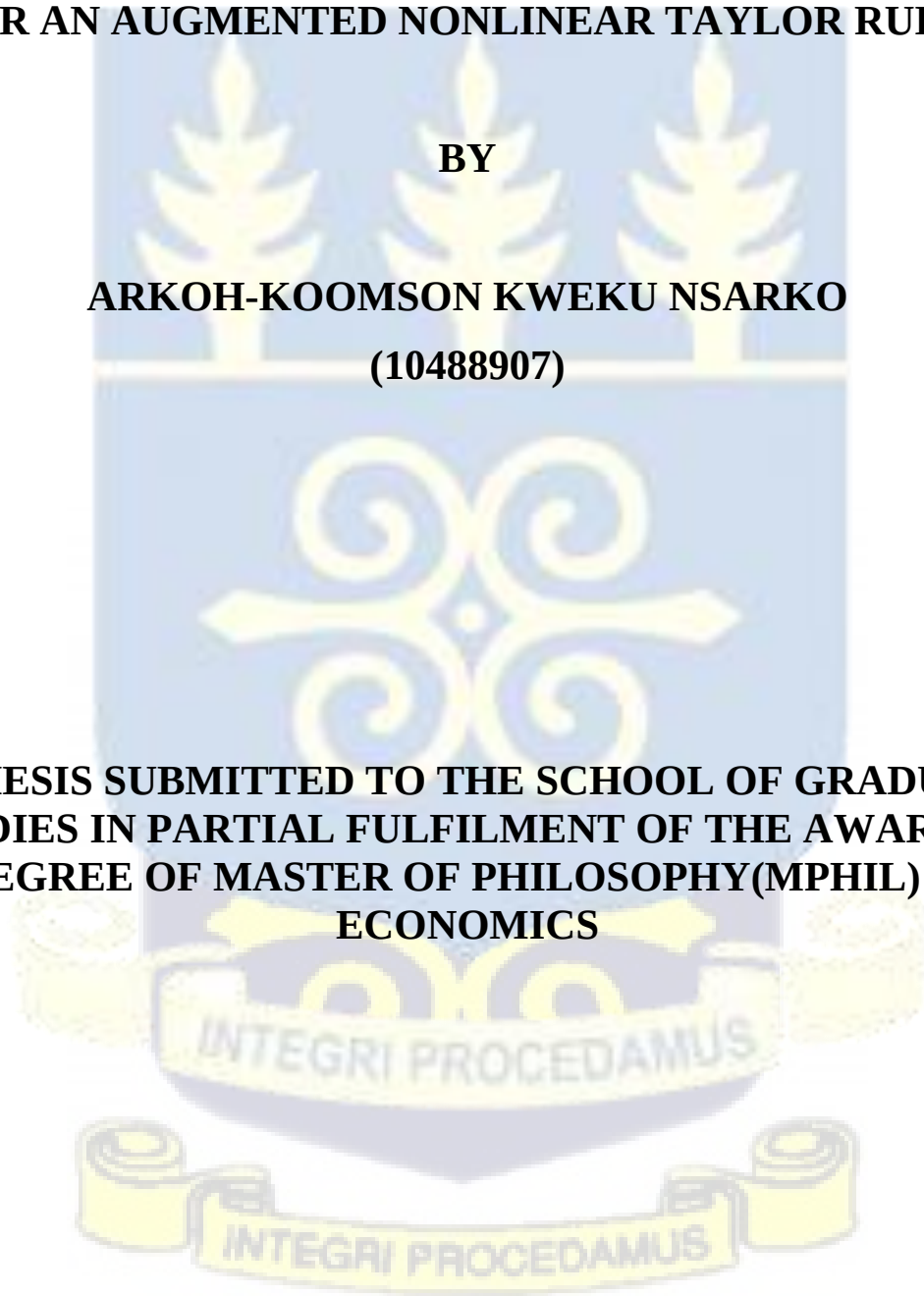
**UNIVERSITY OF GHANA
COLLEGE OF HUMANITIES**

**"MONETARY POLICY RULE IN GHANA: IS THERE A CASE
FOR AN AUGMENTED NONLINEAR TAYLOR RULE"**

BY

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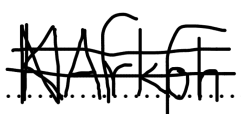
**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE
STUDIES IN PARTIAL FULFILMENT OF THE AWARD OF
DEGREE OF MASTER OF PHILOSOPHY(MPHIL) IN
ECONOMICS**



SEPTEMBER 2021

DECLARATION

I, ARKOH-KOOMSON KWEKU NSARKO, declare that apart from references to other papers that have been appropriately acknowledged, this thesis is the result of original research that I conducted in the Department of Economics at the University of Ghana under the guidance of my supervisors. This thesis has not been submitted for any other academic award, in part or full, in any form. Any omissions or errors are my faults.

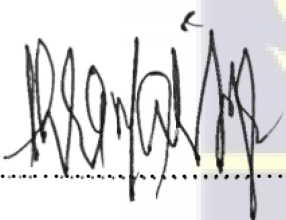

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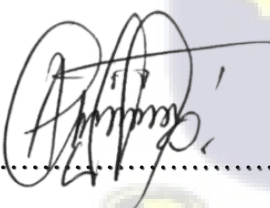
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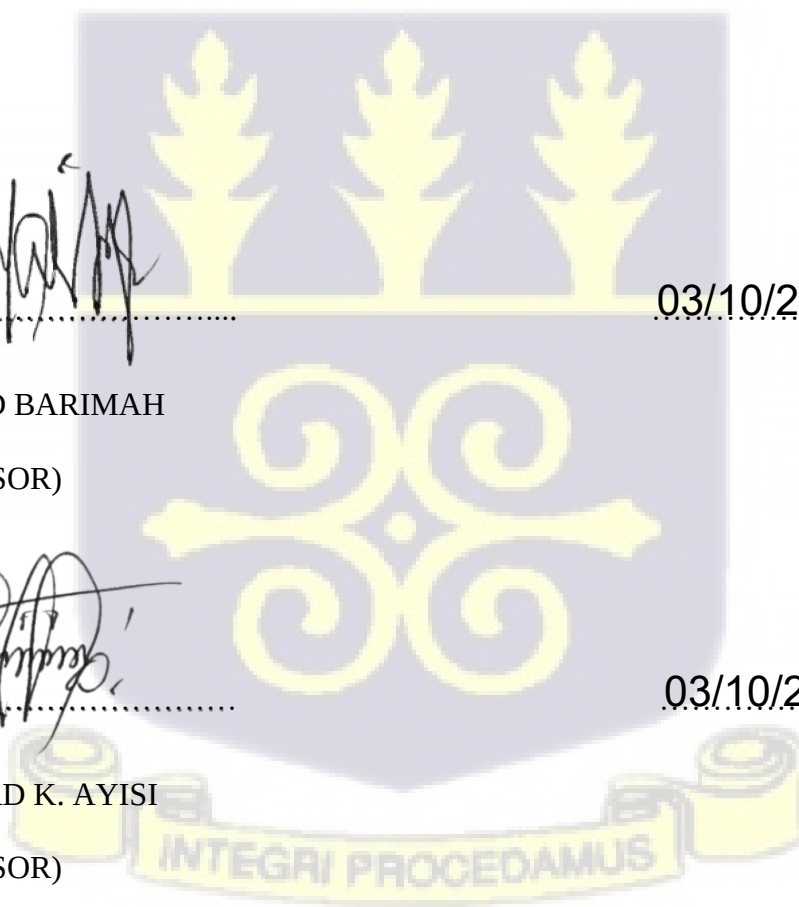
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ABSTRACT

Monetary policy is an essential tool for economic development; hence, management of monetary policy is crucial and must be well understood. An interest rate rule like the Taylor rule was developed to analyze monetary policy conduct and give a clear direction of interest rate setting behaviour. Most studies analyzing monetary policy conduct in Ghana assume linearity and symmetry in conduct from the Central Bank though that may not represent actual policy conduct. This study looked at monetary policy conduct in Ghana from May 2007 to December 2019 (the official inflation targeting period) and investigated possible nonlinearities in monetary policy conduct. Hence monthly data from May 2007 to December 2019 was used. The study used the ARDL and NARDL to investigate asymmetries in monetary policy conduct. The study first observed the importance of the real effective exchange rate in monetary policy conduct as it significantly affected the policy rate decisions. The study found an asymmetric response in deviations in the exchange rates in the short run. In the long run, there was also an asymmetric response to inflation gap deviations as the policy rate reacted strongly to negative deviations but had an insignificant response to positive deviations. The study proposes that for the Central Bank to be effective in the conduct of monetary policy, it must respond to deviations more symmetrically or depict inflation-stabilizing behaviour. This will improve the credibility of policy conduct so that economic agents always know that price stability is always the central bank's primary goal.



DEDICATION

This thesis is dedicated to my parents, Arkoh-Koomson Joseph Kwesi and Theresa Cobbinah, and my siblings, Efua Akoaa Koomson, Ama Akoaa Koomson, Paa Yaw Arkoh-Koomson, Kojo Incoom-Koomson, and all my loved ones.



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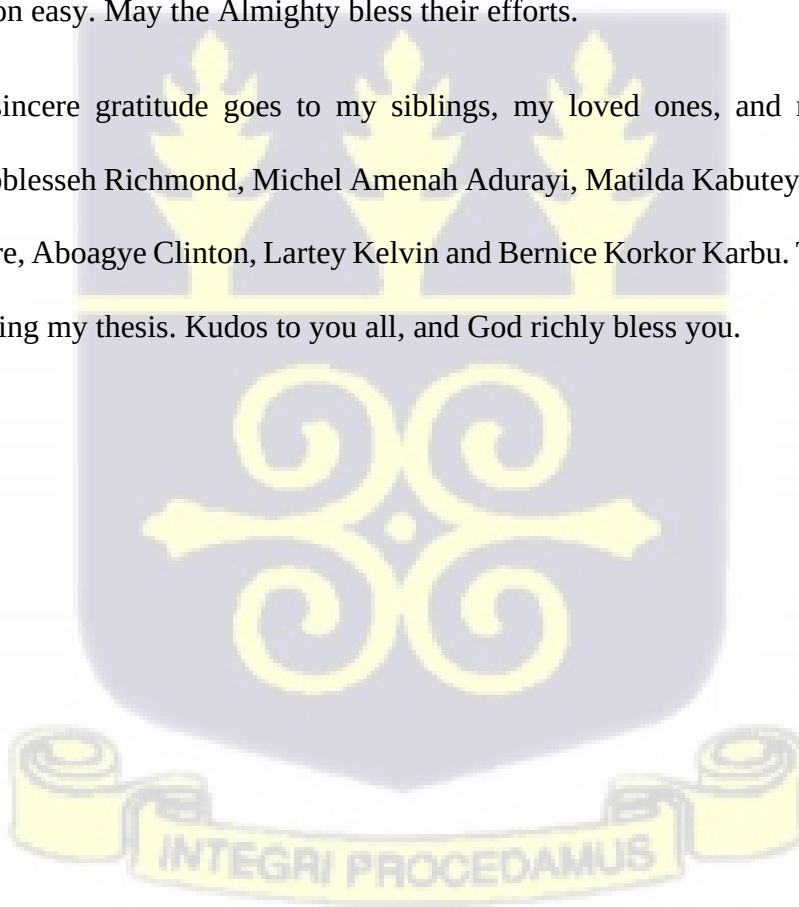


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LIST OF ABBREVIATIONS

AIC	AKAIKE INFORMATION CRITERION
ARDL	AUTOREGRESSIVE DISTRIBUTED LAG
BIC	BAYESIAN INFORMATION CRITERION
BOE	BANK OF ENGLAND
CIEA	COMPOSITE INDEX OF ECONOMIC ACTIVITY
COICOP	CLASSIFICATION OF INDIVIDUAL CONSUMPTION BY PURPOSE
ECB	EUROPEAN CENTRAL BANK
ERP	ECONOMIC RECOVERY PROGRAMME
GMM	GENERALIZED METHOD OF MOMENTS
GSS	GHANA STATISTICAL SERVICE
IMF	INTERNATIONAL MONETARY FUND
MPC	MONETARY POLICY COMMITTEE
MPR	MONETARY POLICY RATE
NARDL	NONLINEAR AUTOREGRESSIVE DISTRIBUTED LAG
OMO	OPEN MARKET OPERATIONS
PSBR	PUBLIC SECTOR BORROWING REQUIREMENTS

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Background of Study

Inflation is a worldwide economic issue that governments are attempting to address to ensure the smooth operation of their economies. Most economies strive for low and steady inflation rates since this is the most efficient way to run an economy. As a result, monetary policy aims to produce low and stable inflation, full employment, financial sector stability, and exchange rate stability, among other things. Most Central Banks prioritize price stability because they think it will enable them to achieve all their other objectives or that price stability will provide the best possibility of fulfilling the Central Bank's objectives. As a result, most monetary policy regulations are geared toward maintaining price stability.

According to Shiller (1997), inflation is disliked by the general public, and inflation is a national concern when its full impacts are examined. Inflationary pressures harm the economy because local items become more expensive on the international market and lose competitiveness. According to Ball & Sheridan (2004), economists have sought an ideal monetary policy approach in which the desirable inflation rate is established as a target to ensure price stability.

As Svensson (1999) puts it, inflation targeting describes adherence to consistent and rational monetary policy compared to any other policy and full transparency and accountability. He notes that with inflation targeting, there is an explicit loss function to be minimized and thus reduces inflation bias the most. Inflation targeting means that monetary policy follows a framework, not just discretion. As Kydland & Prescott (1977) indicated, discretions in monetary policy do not

yield the most effective outcome for the economy. Clarida et al.(1999) stated that central banks committing to rules guiding policy instead of discretion guide the activities and behaviour of economic agents in an economy as commitment makes policy direction clear and believable to economic agents.

There is evidence of a lower stable inflation rate for countries adopting the inflation targeting framework, especially advanced economies. Issues being discussed now are which level of inflation is appropriate to target. According to Friedman (1969), a zero nominal interest rate yields a socially optimal result, indicating that a deflation rate equivalent to the real interest rate should be pursued (implying a negative inflation rate). According to Coibion et al.(2012), the ideal inflation rate is zero because a zero lower bound on inflation reduces the cost of price changes.

However, most economists believe that a zero or a lower inflation rate is bad for the economy due to the negative effects of lowering prices. Most producers would be unmotivated to produce. According to Aiyagari (1990), zero inflation is not recommended since the costs may outweigh the benefits. As a result, measures other than a zero-inflation rate might be explored. Regarding the inflation targeting technique or framework, the target inflation rate serves to anchor inflation expectations for economic actors, causing them to modify their decision-making processes.

According to Mishkin (2019), a nominal anchor imposes an expected constraint on discretionary policy and decreases the central bank's discretionary inclinations. Agents usually predict such reduced objectives in the future due to the transparent nature of inflation targeting.

The achievement of inflation objectives is not always the case. According to Albagli & Schmidt-Hebbel (2004), the nature of quality institutions, the central bank's independence, and the absence of a national risk premium all contribute to inflation levels being closer to goals. As a result,

countries that target inflation but do not satisfy these requirements are unlikely to grow closer to their goal levels. When inflation objectives are regularly missed, economic agents lose faith in the central bank's ability to accomplish its goal, resulting in a loss of credibility. This results in central banks dealing with the issue of time inconsistency. Inflation objectives are announced to give the public information that is used to make decisions (Walsh, 1999).

Taylor (1993) estimated and demonstrated how monetary policy issues in the United States during the 1980s and early 1990s were described by a well-defined linear formula known as the Taylor rule. He believes the Federal Reserve reacted to departures in inflation and production from their respective goal levels of inflation and potential output. This was accomplished by changing nominal interest rates to bring these variables closer to their target values. Clarida et al. (1998) analysed the monetary policy behaviour of the G3 (the United States, Japan as well as Germany) and the E3 (the United Kingdom, Italy, and France). They discovered that they followed the Taylor rule. They did, however, use a forward-looking formulation of the Taylor rule, as opposed to Taylor's scenario, which had the central bank reacting to past values since inflation targeting was predicated on the central bank making decisions based on inflation and output expectations.

Most of the research looked at what other factors might be added to the Taylor rule regarding monetary policy behaviour. Since the central bank aims to stabilize prices, full employment, exchange rates, and financial markets, among other things, researchers wanted to explore if the Taylor rule could be improved to characterize the central bank's monetary policy behaviour better. As a result, variables such as currency rates, asset prices, and financial circumstances were considered.

According to Ball (2000), the Taylor rule has to be altered for open economies to account for exchange rate effects, causing the Central Bank to react to exchange rate changes as well.

Roskelley (2016) demonstrated that when the Taylor rule was augmented with principal components of bond rates, it was a better fit for monetary policy behaviour than the standard Taylor rule.

Nonlinearities in the conduct of monetary policy have also been observed. This is due to the nonlinear structure of several macroeconomic variables' connections. According to Nobay & Peel (2003), a greater output objective decreases inflation variance, enhancing social welfare. There was a nonlinear connection between output and inflation in this fashion.

The problem of the central bank's asymmetric preferences is the one that is being discussed the most. According to inflation-targeting principles, the central bank's goal is to ensure price stability. With this information, Taylor first assumed a symmetric quadratic loss function and constructed a rule that dictated how central banks responded to production and inflation variations. Clarida et al. (2000) argue that the reaction to inflation deviations must be larger than one for the Taylor rule to work. In contrast, the response to output variations must be greater than zero. Because the IS curve representing the goods market is reliant on real interest rates in the formulation, this is the case. As a result, adjustments in nominal rates must be such that they produce changes in real interest rates, allowing inflation to be brought to its objective.

The majority of the research, on the other hand, suggests that the central bank has asymmetric preferences. The symmetric quadratic loss function would not represent the loss functions of central banks with asymmetric preferences. The weight on output gap stabilization in the loss functions to be reduced by central banks, according to Svensson (1999), is not as obvious or transparent, allowing for potential nonlinearities.

Surico (2007) used a linear version of the US Federal Reserve's loss function that considers asymmetry and nests a symmetric quadratic loss function as a particular case. He estimated that monetary policy behaviour before Volcker was characterized by asymmetric preferences, implying that there were nonlinearities in monetary policy behaviour. This may explain why inflation was greater and less steady throughout this period.

Ghana officially adopted the inflation targeting framework in May of 2007. Akosah et al.(2020) stated that due to institutional weakness in Ghana's monetary policy conduct, Ghana became a test case following its adoption of inflation targeting for developing countries. Now, before setting short-term policy rates, the Monetary Policy Committee of the Bank of Ghana considers the information criterion (both domestic and external) available to them. Additionally, the Bank of Ghana has improved communication channels by making decisions regarding monetary policy open to the public to make monetary policy conduct transparent and anchor inflation expectations of economic agents.

1.2 Statement of the Problem

As propounded by (Taylor, 1993), the Taylor rule looked at Central Bank reactions to deviations in output and inflation from their targets. However, a body of work advocates for including other variables like exchange rates and financial asset prices, among others, into the Taylor rule.

Svensson (2000) noted that since most inflation-targeting countries are open economies, there must be consideration of external shocks from other countries that will have an effect. He again stated that the exchange rate adds a channel of monetary policy transmission.

Taylor (2000), however, said that this is not necessary in the case of developed economies as due to stability in their exchange rates, the effects of exchange rates are fully accounted for in responses

to inflation deviations and output deviations. Edwards (2006) highlighted the optimality of incorporating the real exchange rate into the monetary policy rule. However, he stressed that it is not prudent to include real exchange rates in a monetary policy rule if exchange rates are incorporated into modelling inflation and output behaviour. He further highlighted that if the relationship between real exchange rate and output or inflation were not so perfectly modelled, real exchange rates would have a delayed effect on output and inflation. This would make a case for the inclusion of real exchange rate in the monetary policy rule.

Hence, one issue the study seeks to examine is whether the inclusion of exchange rates improves the fit of monetary policy conduct in Ghana compared to the conventional Taylor rule.

Again, Taylor (1993) assumed a symmetric quadratic loss function in formulating the Taylor rule giving rise to the linear specification in the Taylor rule. However, some works stipulate that monetary policy conduct is not always best described by the linear Taylor rule.

Nonlinearities are also due to the nonlinear relationship between macroeconomic variables (Nobay & Peel, 2003). There has been the case of asymmetric preferences that cause nonlinearities in monetary policy rules (Caporale et al., 2018; Cukierman & Muscatelli, 2008; Hasanov & Omay, 2008; Taylor & Davradakis, 2006).

Kasai (2011) indicated that the South African Reserve Bank's response to inflation deviations was dependent on the stage of the business cycle, as, in expansions, response to inflation was higher than in recessionary periods. Asymmetric behaviour is not optimal monetary policy conduct since a response to inflation is less than one in recessions and greater than one during expansions. Such behaviour does not help achieve stability in inflation rates because agents would know that,

dependent on the stage of the business cycle, the central bank can switch between its mandates and focus on other objectives instead of inflation.

Ghana officially adopted the inflation targeting framework in May of 2007. Akosah et al.(2020) stated that due to institutional weakness in Ghana's monetary policy conduct, Ghana became a test case following its adoption of inflation targeting for developing countries. Now, before setting short-term policy rates, the Monetary Policy Committee of the Bank of Ghana considers the information criterion (both domestic and external) available to them. Additionally, the Bank of Ghana has improved communication channels by making decisions regarding monetary policy stance open to the public to make monetary policy conduct transparent and anchor inflation expectations of economic agents.

However, after employing inflation targeting for over a decade, Ghana's inflation is persistently above the $8\% \pm 2\%$ target. Bleaney et al.(2020) asserted that the mean expected inflation and actual inflation from 2007 to 2017 is 14.5% and 13.6%, exceeding our target. Bleaney et al.(2020), in their paper though, suggested that the long-run estimates of a linear monetary policy rule (Taylor rule) showed that the responses to output and inflation deviations had the right signs and magnitudes suggested by theory. Therefore, they ask how inflation is persistently above its target if monetary policy is being conducted correctly.

Now Taylor (1993), in developing the interest rate rule, disregarded possible asymmetries. Thus, a Taylor rule comes from two assumptions; first, it assumes a symmetric quadratic loss function, and second, it assumes a linear Phillips curve. The idea of symmetric responses to deviations in inflation and output has been questioned by some researchers (Mishkin & Posen, 1998; Orphanides & Wilcox, 2002). Cukierman (2000, 2002) refers to how Central Banks are blamed for higher unemployment when measures are implemented to reduce inflation. He posits that some politicians

view high employment levels as good and thus prefer positive output gaps. He concluded that the loss function's symmetric nature was chosen due to its flexibility analytically and not being representative of the real-life phenomenon.

This study thus seeks to explore whether there is a case for an augmented nonlinear Taylor rule due to asymmetric preferences for the monetary policy conduct in Ghana. This would help propose measures to assist in monetary policy conduct in Ghana. Different responses to deviations in the same variables may make economic agents lose credibility in the Central Bank.

1.3 Research Questions

The study seeks to ask the following questions.

- i. Does the Bank of Ghana incorporate exchange rates independently into its monetary policy rule?
- ii. Does the Central Bank react symmetrically to deviations in output, inflation, and exchange rate or does the Central Bank react asymmetrically?

1.4 Research Objectives

Broadly, this study will estimate the reaction function of the Bank of Ghana using the interest rate rule propounded by Taylor (1993). This study will investigate the presence of asymmetries in the monetary policy conduct of Ghana and determine whether it is optimal. The objectives of the study are

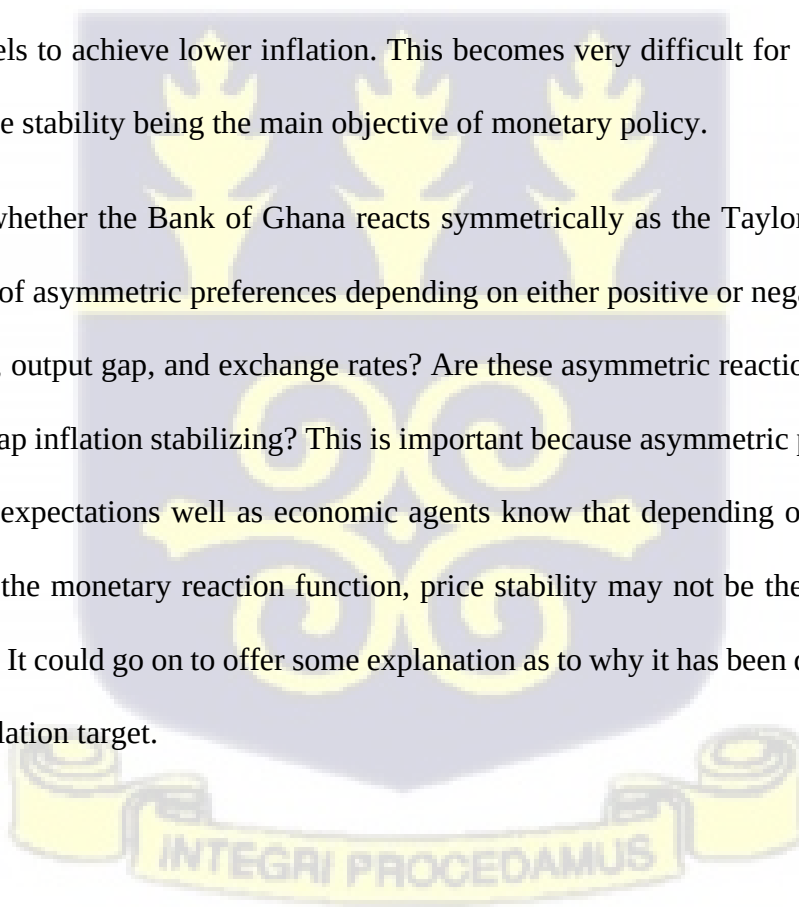
- i. To investigate whether Ghana's monetary policy reaction function incorporates the exchange rate independently or not.
- ii. To investigate asymmetric preferences on the part of the Central Bank with regards to positive and negative deviations of inflation gap, output gap, and exchange rate.

1.5 Justification and significance of the Study

The focus of monetary policy in Ghana currently is price stability. The inflation-targeting framework is utilized officially by the Central Bank. Now, the direction with which the monetary policy rate in Ghana moves determines the stance of monetary policy, making the inflation targeting framework transparent. Thus, economic agents always know inflation is the primary focus of monetary policy to anchor their expectations of inflation. Therefore, monetary policy's credibility is vital as it helps bring inflation under control or stabilize it.

Crowe & Meade (2007) argues that dynamic inconsistency is a major challenge of monetary policy. This is because, to reduce inflation, the Central Bank would have to give up some employment levels to achieve lower inflation. This becomes very difficult for the Central Banks to stick with price stability being the main objective of monetary policy.

Hence, we ask whether the Bank of Ghana reacts symmetrically as the Taylor rule demands. Is there a presence of asymmetric preferences depending on either positive or negative deviations in the inflation gap, output gap, and exchange rates? Are these asymmetric reactions to the inflation gap and output gap inflation stabilizing? This is important because asymmetric preferences do not anchor inflation expectations well as economic agents know that depending on the deviation in key variables in the monetary reaction function, price stability may not be the primary focus of monetary policy. It could go on to offer some explanation as to why it has been difficult for Ghana to achieve its inflation target.



1.6 Organization of the study

This study is divided into six chapters. Chapter one looks at the background of this study, the problem statement, the objectives of this study, the questions this study seeks to address, the significance or justification of this study, and how the study will be organized. Chapter two will focus on what the literature says about inflation targeting and monetary policy rules, both theoretically and empirically. Chapter three gives an overview of the Ghanaian economy concerning inflation performance, monetary policy, and monetary policy conduct. The fourth chapter looks at the methodology used to conduct this study and a detailed discussion of data sources and the appropriate tests to be conducted. Chapter five looks at and discusses the findings obtained from the study. Chapter six looks at the conclusion of this study and the policy recommendations from the study.



CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter looks at monetary policy and how it is implemented. It examines literature recommending or advocating the use of policy rules over discretion since rules are guidelines for policy action (Svensson, 1999). As a result, this chapter focuses on monetary policy and policy norms, as well as inflation targeting, which provides transparency and a commitment to rational policymaking. The theory of nonlinearities in monetary policy behaviour is also examined in this chapter. There are two parts to this chapter. The theoretical literature on monetary policy rules and inflation targeting is reviewed in the first part. The empirical research on policy rules and asymmetry in monetary policy action is examined in the second section.

2.1 Theoretical Literature Review

The literature on monetary policy rules and conduct is expansive for developed countries, but not much work has been done on it in developing countries, especially Ghana. Investigations of asymmetry in policy conduct are mostly restricted to the industrialized or developed nations, with very few studies in developing countries, especially the African continent. Monetary policy is an essential tool in achieving set objectives by the Central Bank as it is observed from studies in macroeconomics that prudent monetary policy conduct is essential for growth and development.

2.1.1 Monetary policy and Rules of monetary policy conduct

Monetary policy is the central bank's demand-side macroeconomic course of action or strategy for achieving macroeconomic goals, which is accomplished through managing money and credit

supply or modifying interest rates. When the Central Bank of England created gold-backed notes in 1699, the concept of monetary policy was born. Later, between 1870 and 1920, the advanced or industrialized nations established a Central Bank to set monetary policy. The main goal of monetary policy differs for each country, but they are all the same: stabilizing inflation, maintaining exchange rate stability, and stabilizing economic activity. Policy measures such as discount window, open market operations borrowing, and reserve requirements are used to maintain monetary stability. Monetary policy's operating aim is either through a pre-determined rule or a discretionary choice.

Simons (1936) first highlighted the problem of monetary policy norms vs discretion and favoured policy standards for economic stability. Discretion is the authority to improve economic performance by taking decisions based on sentiments, whereas rules are seen as a limitation. Several famous economists, including Mccallum (1988), Kydland & Prescott (1977), Barro & Gordon (1983), Fischer (1979), and Taylor (1993), have called for monetary policy rules over discretion.

Mccallum (1988) and Taylor (1993) popularized the concept of rule as a practical guide for monetary policy. McCallum recommended changing the money growth rate to react to deviations in inflation and GDP growth rates. The Taylor rule prescribed changes in short-term interest rates in reaction to changes in the output gap, and inflation exhibits a linear relationship. Taylor (1993, 1999) suggested that the policy behaviour or path of the Central Bank can be guided by an interest rate rule which is popularly known as the Taylor rule. This rule looked at deviations of output and inflation from their respective targets and how interest rates would react to these deviations. The Central Bank's response to inflation, output deviations from their target, and potential levels are linear and symmetric, thanks to the assumptions underlying the quadratic loss

function and the linearity of the Phillips curve.

Many economists have questioned the linear Taylor rule because of its assumptions, and if these assumptions are relaxed, the monetary policy reaction function becomes nonlinear. Central bankers' preferences for economic activity stability and stabilization of inflation rate are treated symmetrically, presumably for mathematical simplicity. Still, these choices may be asymmetric due to political pressure or by choice (Blinder, 1998). When output falls short of its potential (unemployment rises) or inflation rises above its target, policymakers are more likely to take drastic measures. When output exceeds its potential, unemployment is lower, or inflation is below target, the reaction to such deviations is less severe. This behaviour is very similar to human psychology, in which people want to avoid loss while embracing joy, expansion, and rewards.

Furthermore, the Phillips curve is shown to be convex rather than linear, indicating that at any point along the curve, a rise in the inflation rate is more necessary to reduce unemployment than a reduction in the inflation rate if the same amount increases unemployment. During an upswing, inflation reacts significantly to extra demand, but during a recession, it becomes indifferent to output (Laxton et al., 1999). Phillips curve convexity is also encouraged by downward wage rigidity. The optimal monetary policy reaction also becomes nonlinear when the Phillips curve is nonlinear.

2.1.2 What is Inflation Targeting?

Inflation targeting is defined by Bernanke et al.(1999) as “a framework for monetary policy characterized by the public announcement of official quantitative targets or target ranges for the inflation rate over one or more time horizons, as well as the explicit acknowledgement that low, stable inflation is monetary policy's primary long-run goal.”

Inflation targeting, according to Mishkin (2007), consists of five major elements:

- a) Public declaration of the medium-term numerical inflation objective
- b) Institutional devotion to price stability is the principal long-term goal of monetary policy, as well as meeting the inflation target
- c) An information-inclusive method in which monetary policy choices are based on various factors rather than just monetary aggregates.
- d) Increased openness of monetary policy approach through public and market communication regarding monetary policymakers' aims and objectives
- e) The central bank will be held more accountable for meeting its inflation targets.

Some Central Banks across the world, since the early 1990s, have adopted the inflation targeting framework as the basis for monetary policy (Bernanke & Mishkin, 1997). This is because inflation targeting offers several benefits, such as

- 1. It gives the Central Banks more independence
- 2. Ensuring the credibility of the Central Bank by reducing inflation
- 3. Helping to reduce future uncertainty about inflation
- 4. Transparency is granted by improved communication between policy makers and economic agents or the public (Bernanke & Mishkin, 1997)

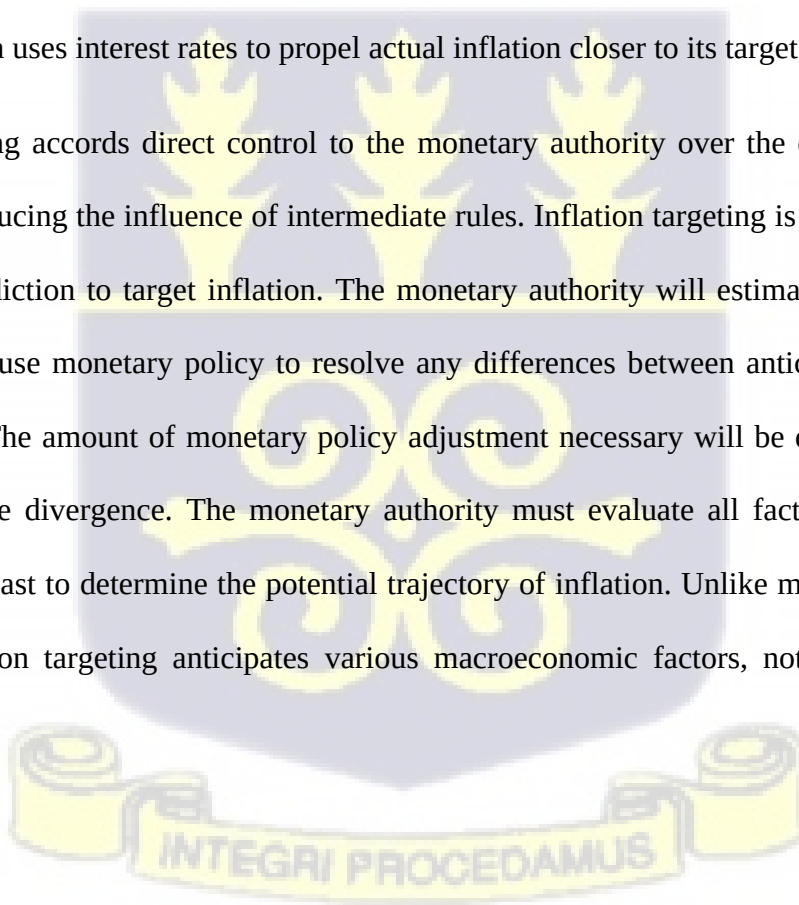
Subscribing to the inflation targeting framework means lower and stable inflation can be achieved or obtained at the expense of output (Bernanke & Mishkin, 1997). Clarida et al.(2000) found the effectiveness of inflation targeting in bringing down inflation by comparing the pre-Volcker period to the period after Volcker was appointed Fed chairman in 1979. They found that since Volcker adopted a more aggressive stance on inflation using the inflation targeting framework, he achieved

low and stable inflation rates.

In 1990, New Zealand was the first country to implement inflation control legislation. The United Kingdom, Canada and Sweden were among the first countries to adopt it in 1992, 1991, and 1993 respectively. South Africa was the first African country to employ Inflation Targeting, and Ghana followed suit. The Bank of Ghana originally used inflation targeting in 2002, although it wasn't publicly revealed until May 2007. Ghana introduced inflation targeting to prevent the economy from collapsing, which was warranted due to intolerable inflation levels. Inflation peaked at around 117% in 1981 and hovered around 123% in 1983. (Gyebi & Boafo, 2013).

Many countries have used inflation targeting as their monetary policy framework throughout time. The central bank announces a target inflation rate within the inflation targeting framework. The central bank then uses interest rates to propel actual inflation closer to its target.

Inflation targeting accords direct control to the monetary authority over the expected inflation trajectory by reducing the influence of intermediate rules. Inflation targeting is all about utilizing an inflation prediction to target inflation. The monetary authority will estimate future inflation trends and then use monetary policy to resolve any differences between anticipated and actual inflation rates. The amount of monetary policy adjustment necessary will be determined by the magnitude of the divergence. The monetary authority must evaluate all factors that impacted inflation in the past to determine the potential trajectory of inflation. Unlike monetary aggregate targeting, inflation targeting anticipates various macroeconomic factors, not only the money supply.



2.2 Review of Empirical Literature

Several empirical studies have been conducted to ascertain whether the Taylor rule can describe Central Bank behaviour. Most studies have found that the Taylor rule describes monetary policy conduct in most advanced countries that target inflation. Although few studies have been carried out in Africa, especially Ghana, they also affirmed that the Taylor rule describes monetary policy conduct in Ghana. However, the literature on the investigation of nonlinearities in monetary policy in Ghana is scant as much has not been done here as compared to numerous studies in advanced countries though issues such as fiscal dominance and political pressure undermine the independence of the Central Bank (Akosah & Alagidede, 2019; Bleaney et al., 2020).

2.2.1 Empirical Evidence on Linear Taylor Rule in Monetary Policy

Taylor (1993) estimated and showed how monetary policy for the US during the 1980s and early 1990s was explained by a clearly defined linear rule termed the Taylor rule. He opined that the Federal Reserve reacted to deviations in inflation and output from the target level of inflation and potential output, respectively. This was done by adjusting nominal interest rates to guide these variables to their desired levels. Stuart (1997) also studied that by comparing the interest rule propounded by Taylor to actual nominal rates in the UK, there was reason to believe that the Taylor rule informed the direction with which interest rates were guided in the UK.

Clarida et al. (1998) considered the Taylor rule on two country groups, that is, the G3 (Japan, USA, and Germany) and the E3 (Italy, the UK, and France). The study established that, for the G3 countries, adjustments made on real interest rates to account for inflationary pressures followed a forward-looking specification instead of the backwards-looking specification rule opined by Taylor. The E3 had their policy reaction function (interest rate rule) to be quite like that of the rule implied by the German Bundesbank.

Gerlach & Schnabel (2000) demonstrated that interest rate behaviour in the European Monetary Union countries moved as suggested by the Taylor rule. The European Central Bank conducted monetary policy using the interest rate rule implied by Taylor (Taylor rule). Taylor (2013) found that in terms of price and output stability, following rule-based monetary policy was better for the US than a case of non-adherence.

However, Svensson (1999) suggested that in practice, central banks do not strictly follow such simple instrument rules, either it is explicit or implicit. Still, they rather use more information than that suggested by these simple rules. Again, Svensson (2003) opined that a problem with simple interest rules is that they do not leave any room for adjustments in judgements or look at other information outside the model, which might be key in determining the actions of a central bank. He utilizes instances where events like the Stock Market crash and the Asian Crisis occur. Central banks would judge and react to such events even though simple instrument rules may not necessarily suggest so. Martin & Milas (2013) pointed out that the Taylor rule gave a good account of the interest rate behaviour of the UK during the no-crisis regime between 1992 to 2007. However, it broke down during the financial crisis in 2007, where interest rates did not respond to deviations in inflation per se but responded to the state of the financial market. Thus, there was more focus on financial stability rather than strictly following the directions of the Taylor rule.

Other issues have also been raised, such as how real-time output gap estimates are unreliable. Orphanides (2000) suggested that inaccurate measurements of output and unemployment could lead to errors in rules where gaps of these variables are responded to. Thus, he attributed much of the US inflationary problems in the 1970s to monetary policy resembling the Taylor rule, where there were inaccurate measurements of the output gap.

Orphanides & Norden (2002) brought up some issues that hinder the accurate measurement of the

output gap. Revision of data is one factor that changes the estimated output gap. That is, the output gap estimated using real-time data may be different from data from that same period if there is a revision in data measurement or criteria considered in data collection. They also suggested that the model may be revised when an influx of new data changes the measure for output gaps.

Hatipoglu & Alper (2008) also clarified that the Taylor rule suggests that the Central Bank has perfect information about the output gap in a particular period, which is not entirely the case. They also said that if there is a severe output gap mismeasurement, then monetary policy will be to the tune of activist stabilization policy and not try to bring down inflation.

The smoothing measure developed by Hodrick & Prescott (1997), popularly known as the Hodrick-Prescott filter, is the most used for potential output. As noted by Cerra & Saxena (2000), the Hodrick-Prescott filter is increasingly popular due to the flexibility in following any fluctuations in the output trend. However, they also stated some shortcomings with its usage.

Cerra & Saxena (2000) stated that one of the shortcomings of the Hodrick-Prescott filter is that there is no appropriate level of the detrending parameter such that we obtain the best measure of potential output. Cerra & Saxena (2000) and Shortland & Stasavage (2004) also pointed out that the accuracy of predicting the potential output reduces as more recent observations are approached or toward the end of the sample. Another issue with the Hodrick-Prescott filter, as pointed out by (Hatipoglu & Alper, 2008) is that the Hodrick-Prescott filter performs well when potential output is estimated in the case of developed countries. However, it is not suitable for emerging or developing countries since they are prone to external shocks and thus display high variation in the output trend indicators.

Another issue with the Taylor rule is that there are just immediate adjustments when inflation or

output deviations. As pointed out by (Clarida et al., 2000), the central banks usually smooth changes in interest rates instead of immediately adjusting. This was confirmed in the case of Ghana by Bleaney et al. (2020) and also by Akosah et al. (2020). They confirmed that the Bank of Ghana typically smooths over changes in interest rate in the short run which helps not cause major distortions in the financial markets. Bawumia et al. (2008) also described Ghana's monetary policy conduct as following the Taylor rule. They also concluded that there was some degree of interest rate smoothing.

These studies provided insight into monetary policy conduct in Ghana. Still, Bawumia et al. (2008) did not consider the exchange rate's impact on inflation, necessitating the incorporation of exchange rates into the Central Bank's reaction function. Loloh (2014) concluded that there was a high pass-through of exchange rates into inflation. Hence, it will be essential to account for exchange changes in the monetary policy reaction function of the Central Bank.

2.2.2 Review on Augmented Taylor Rule

Most works on inflation targeting consider just the transmission mechanism of monetary policy in a closed economy. Hence, the role of the exchange rate is not considered though it may help explain monetary policy conduct as central banks also seek to stabilize exchange rates.

Ball (1999) indicated that the Taylor rule is considered an optimal monetary policy rule for a closed economy. However, for an open economy, he advocated for a rule that incorporates exchange rates. Thus, central banks form a Monetary Conditions Index, a weighted sum of interest rate and exchange rate to encapsulate exchange rate effects on output and inflation. He establishes that accounting exchange rates using the MCI reduces variance in inflation compared to other policy rules.

Svensson (2000) noted that since most inflation-targeting economies are open economies, shocks from other countries will affect another country. He stated that the exchange rate added additional monetary policy transmission channels. Svensson (2000) added that real exchange rates affect the demand for local and foreign goods through the aggregate demand channel in an open economy. He stated again that there is a direct effect of the exchange rate on inflation as the level of the exchange rate will determine the price of foreign goods in local currency. Thus, changes in exchange rates affect the price of foreign imported goods which feed directly into the CPI. Therefore, it will be prudent to consider exchange rate deviations from a target.

Ball (2000) also indicated that Taylor rules are optimum for closed economies that do not consider the effect of exchange rates but respond to just output and inflation. However, it needs to be adjusted to account for exchange rate changes and how it affects central bank decisions in open economies since the exchange rate is also essential to the central bank in the conduct of monetary policy.

Leitemo & Söderström (2005) conclude that the exchange rate is an integral part of monetary policy and hence should be included in the monetary policy rule of the central bank. They added that exchange rates being added to a Taylor rule offers some gains, though slightly in output stability. However, if exchange rate effects are added, the policy rules become more sensitive to model uncertainty than the traditional Taylor rule.

Edwards (2006) pointed out that it would be optimal for a small open economy if the monetary rule incorporated real exchange rates. He pointed out that it is not clear if policymakers should give an independent role to the exchange rate or just looking at its effects on inflation and output would be enough. He said that if authorities carefully modelled inflation behavior and output by incorporating the impact of exchange rates on them, it would not be necessary to include exchange

rates separately. However, suppose there was to be a delay with which both inflation and output respond to exchange rates (that is, there is a lagged response to exchange rate). In that case, the central bank may intervene pre-emptively to deal with any effects of exchange rates, thus also making a case for an independent inclusion of exchange rates in the monetary policy rule.

Lubik & Schorfheide (2007) considered the conduct of monetary policy in Canada, the UK, Australia, and New Zealand, where they investigated whether these central banks do respond to exchange rate movements. They specified a structural general equilibrium model and obtained that though the central banks of Australia and New Zealand do not react to movements in exchange rates, the central banks of the UK and Canada responded to exchange rate movements.

Taylor (2000) suggested that because exchange rate fluctuations are an issue for most emerging economies, the Taylor rule can indeed be improved upon by the addition of exchange rate but for only developing economies. He said this is the case because for the rule he specified for the US, due to stability in exchange rates, exchange rate changes are factored into the output channel or through how foreign prices would affect local prices and thus excludes it from the case of the US. Therefore, for developing economies, including a new variable (exchange rate) into the Taylor rule may offer some gains to reducing and stabilizing inflation due to large fluctuations in their exchange rates. He also suggests that for emerging economies, there should be some modification to the monetary policy rules (Taylor rule). Influences of variables like exchange rates must be accounted for, and central banks must monitor and respond to other economic events like financial stability.

Daude et al.(2016) pointed out that in the case of emerging economies operating a flexible exchange rate regime, exchange rate intervention is due to attempts to maintain some comfort zone with exchange rates. Hence, Central Banks will move to deal with any deviations from equilibrium

to contain any amounts of deviations deemed potentially damaging to the economy. Klau & Mohanty (2011) said, in practice, that emerging economies intervene to stabilize exchange rates because most shocks to exchange rates for developing countries tend to be persistent and significant and hence do not wish to absorb all the consequences of such shocks. Thus, in the conduct of monetary policy, central banks tend to react to exchange rates by utilizing interest rates as the policy tool.

Aizenman et al.(2011) utilized a fixed-effects least-squares estimation where they estimated Taylor rules for 16 countries that are classified as emerging economies. They found that inflation targeting central banks considers real exchange rate movements in monetary policy. Garcia et al.(2011) found that increasing the weight on the exchange rate in the policy rule (Taylor rule) for advanced economies increases volatility in both the output and inflation. For emerging or developing economies, however, increases from zero to a certain point (0.75) lead to a decline in output volatility. Hence, they conclude that though it is beneficial to include exchange rates in the policy reaction function or policy rule, the appropriate weights must be assigned.

Shrestha & Semmler (2015) utilized an autoregressive distributed lag approach and established that small open economies in the conduct of monetary policy have to account for external constraints and financial stability. Caglayan et al.(2016) also utilized a theoretical model to study an open economy using the New Keynesian Dynamic Stochastic General Equilibrium model and found that policymakers react to other factors, including real exchange rates, output and inflation gap.

Taylor (2013a) suggested that deviations in interest rate setting behaviour through adherence to the Taylor rule may be because of other central banks' desire to limit fluctuations in the exchange rate. A central bank keeping interest rates lower would depreciate their currency which means

appreciation of the foreign currency compared to the local currency. Hence, the other central banks would resist such large appreciations by limiting or cutting interest rates. Thus, these actions are not recommended by the Taylor rule but are still undertaken.

In Ghana, Bleaney et al. (2020) concluded that the monetary policy rate did not react to exchange rate changes, as exchange rates did not significantly determine the policy rate.

Bleaney et al. (2020) did not account for possible nonlinearities and considered symmetrical reactions to positive and negative deviations in the variables in the monetary policy reaction function. Again, many studies utilize the GMM method of estimation, but there is a key weakness in using the GMM: weak identification when non-stationarity is taken into account (Han, 2012). Hence, the ARDL method has the upper hand in dealing with nonstationary data though it is also limited to just $I(0)$ and $I(1)$, all variables used in this study are such.

2.2.3 Review of Nonlinear Taylor Rule

There has been a further investigation into the nature of the reaction functions of central banks. Taylor (1993) originally assumed that the central bank sought to minimize a symmetric loss function and thus obtained the interest rule on a symmetric loss function. Central banks may not necessarily have such a symmetric loss function or symmetric preferences. It may be the case that central banks have asymmetric preferences. It can also be that the relationships between macroeconomic variables are nonlinear, thus supporting an idea of a nonlinear rule. As Nobay & Peel (2003) showed, as potential output increased, inflation variance was lowered, which speaks to a nonlinear relationship between inflation and output. Thus, the reaction function of central banks may be characterized by nonlinearities.

It has been found that some central banks have different policy responses based on the phase of

the business cycle, where policy responses are different for recessions and different for expansions. Taylor & Davradakis (2006) estimated a monetary policy rule for the UK where they noticed that when the inflation rate was less than the threshold inflation rate of 3.1%, the monetary policy rule collapsed to just a random walk where interest rates were determined randomly. However, if the inflation rate was above 3.1%, the monetary policy followed a forward-looking specification of the Taylor rule.

Surico (2007) also found that during the pre-Volcker years in the USA, the monetary policy rule was nonlinear as larger weights were attached to output contractions than output expansions for the conduct of monetary policy. Castro (2011) also confirmed using a Smooth Transition Regression model that there was evidence of nonlinearities in the conduct of monetary policy by the ECB and BOE. For the ECB, it was observed that a point target of 2.5% was set implicitly. The ECB reacted actively when inflation was above the target but was more accommodative when it was below the target. For the BOE, a target range of 1.8% to 2.4% was pursued implicitly, and they as well reacted actively to inflation when it was above this range. But when inflation was within the target range, the BOE reacted more to the business cycle.

We have looked at cases of nonlinearity in developed economies. However, the evidence for developing together with emerging economies is minimal. Hasanov & Omay (2008) sought to look for possible asymmetries in monetary policy conduct in Turkey. They utilized a Threshold GMM technique where the transition or threshold variable was output gap where a monetary response function based on recession periods was estimated and that for expansions was also estimated. They found that the central bank reacted aggressively to output deviations during recessions. Hence, the Central Bank displayed asymmetric preferences where they do not respond to deviations in output equally. They then concluded that this could be why stabilization programs

have failed to reduce and stabilize inflation due to the asymmetric nature of monetary policy conduct.

Miles & Schreyer (2012) explored the case of a nonlinear monetary policy reaction function in Indonesia, South Korea, Malaysia, and Thailand using Quantile regression. They estimate some nonlinearities in the monetary policy setting behaviour in all four countries where the magnitude of their responses varies according to quantiles, and there are cross-country differences in their responses. In the case of Indonesia, they found that the Central Bank was not responsive to the output gap in lower quantiles ($\tau = 0.2$ and $\tau = 0.4$). Caporale et al. (2018) used threshold GMM, which accounts for nonlinearity, to analyze the rule for Israel, Indonesia, South Korea, Thailand and Turkey, and discovered that an augmented nonlinear Taylor rule represented monetary authorities' behaviour more accurately.

Kasai (2011), in his thesis about the Analysis of Monetary Policy rules for South Africa, found that a nonlinear specification best describes the monetary policy conduct in South Africa. He found that the South African Reserve Bank's response to inflation deviations was greater during business cycle expansions, with a lesser response in times of recessions.

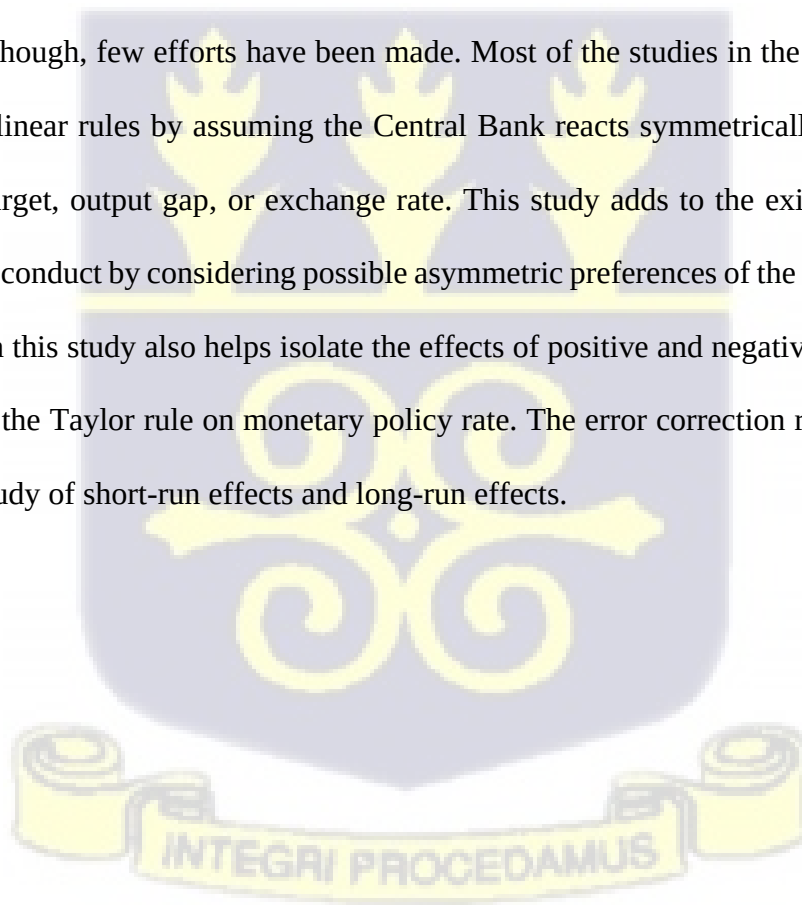
In Ghana, Akosah et al.(2020) investigated the nonlinear monetary policy rule in Ghana using a Multiscale Bayesian Quantile regression approach and concluded that, indeed there was an asymmetric response to the inflation gap. They also investigated using the threshold autoregressive approach and rejected the null hypothesis of linearity in the monetary policy rule, indicating that a nonlinear rule best described monetary policy conduct in Ghana.

Most of these studies are focused on advanced economies, with just one focused on nonlinear monetary policy rule in Ghana. However, the estimates by Akosah et al.(2020) were in the dynamic

form; hence, the long-run relationships that conclusions were drawn on were not statistically tested or established. One advantage of using the NARDL is that the Bounds Testing approach helps establish long-run relationships, which are essential in observing the Central Bank's behaviour. Some studies assumed that a variable like interest rate is theoretically stable; as such, they assumed it to be stationary though stationarity tests conclude otherwise (Caporale et al., 2018; Castro, 2011; Clarida et al., 2000). The NARDL, however, is very good for variables that are all $I(0)$, all $I(1)$, or a mixture of $I(0)$ and $I(1)$ variables in terms of stationarity.

2.3 Conclusion

The literature on monetary policy conduct has concluded chiefly that for inflation-targeting countries, their conduct of monetary policy can be explained by the Taylor rule. In studying the Ghanaian case, though, few efforts have been made. Most of the studies in the Ghanaian context just focused on linear rules by assuming the Central Bank reacts symmetrically to deviations in inflation from target, output gap, or exchange rate. This study adds to the existing literature on monetary policy conduct by considering possible asymmetric preferences of the Central Bank. The model utilized in this study also helps isolate the effects of positive and negative deviations of all key variables of the Taylor rule on monetary policy rate. The error correction reparameterization allows for the study of short-run effects and long-run effects.



CHAPTER THREE

MONETARY POLICY CONDUCT AND INFLATION PERFORMANCE IN GHANA: AN OVERVIEW

3.0 Introduction

This chapter provides a general overview or outlook of concepts in the Ghanaian setting. Hence, this chapter seeks to review inflation measurement, the performance of inflation, the framework of inflation targeting in Ghana, and how monetary policy is conducted in Ghana.

3.1 Measurement of Inflation in Ghana

Inflation is defined as a rise in the overall level of prices of goods and services over time. This does not suggest that inflation is only concerned with short-term price increases. Most people assume that lowering the pace of inflation means lowering the price. This is a flawed assumption. A reduction in the inflation rate refers to a slowing in the rate at which the total price level of goods and services grow.

Ghana's inflation data are calculated and published by the Ghana Statistical Service (GSS). They rely on the Consumer Price Index (CPI), which measures changes in the cost of household goods and services. A household spending survey is conducted by the Ghana Statistical Service as part of more extensive research to decide which products will be included in the CPI basket of goods and services.

As a result, popular items and services are picked to create a basket of goods and services. Following the last review in 2012, the commodities basket is evaluated regularly, with the most recent review in 2019 using 2018 as the base year. Old goods and services no longer in use are

removed from the basket to produce a new CPI, and new commodities and services discovered through the survey are added. In order to create the new CPI in 2019, the basket of goods and services was raised from 267 to 307 items. The CPI is being revised for the sixth time, with 2018 as the base year.

Table 3. 1: CPI classification of households' consumption expenditures and the Weights

	National Overall indices	100.00
Items	Description	<i>weight</i>
1	Food and Non-Alcoholic Beverages	43.12
2	Alcoholic Beverages, Tobacco & Narcotics	3.71
3	Clothing and footwear	8.07
4	Housing, water, electricity, gas, and other fuels	10.23
5	Furnishings, household equipment, and routine household maintenance	3.19
6	Health	0.74
7	Transport	10.14
8	Information and communication	3.63
9	Recreation, sport, and culture	3.47
10	Education services	6.50
11	Restaurants and accommodation services	4.56
12	Insurance and financial services	0.23
13	Personal care, social protection, and miscellaneous goods and services	2.43

Source: Ghana Statistical Service 2019

These 307 items are categorized and weighted using the United Nations Statistics Division's COICOP aggregation structure, a technique for classifying products and services (United Nations COICOP, 2018). According to COICOP, the Ghana statistical agency categorizes these 307 products into 13 primary groupings based on household consumption expenditure trends. The prices of these products in 2018 are used as a baseline, and any changes over time, such as monthly, quarterly, and yearly, are calculated as the inflation rate.

3.2 Performance of Inflation in Ghana

Despite the employment of various monetary policy measures, monetary authorities in Ghana have consistently followed a desire to attain price stability. Regardless, instability and high inflation volatility have been the outcome for several years. The inflation rate from 1961 to 2019 is depicted in Figure 1 (1).

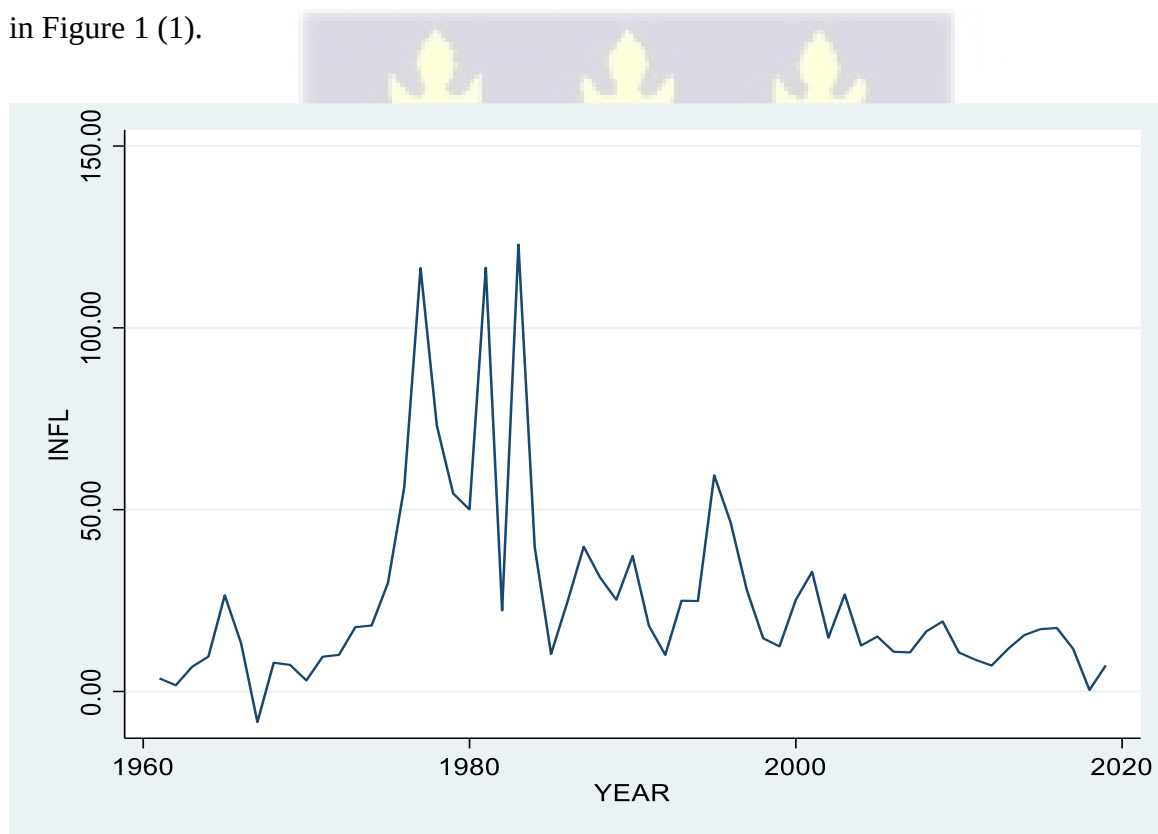


Figure 3. 1: The Graph of Inflation Rates from 1961 to 2019

Source: Ghana Statistical Service and Bank of Ghana Annual Reports

The inflation rate which is calculated using CPI, is shown in Figure 3.1 above. With the volatility of the 1980s apparent, inflation is primarily high. From 2000 forward, however, there is an indication of stability. In addition, the conduct of inflation in correspondence with the goals of monetary authorities is equally important to us. The current inflation rate is compared to the formal target rate of 8% (with a 2% symmetric band) in Figure 2 (2) below. Ghana unofficially started the Inflation targeting regime in 2002 with the Bank of Ghana Act, 2002 (Act 612), but an official regime announcement was made in 2007.

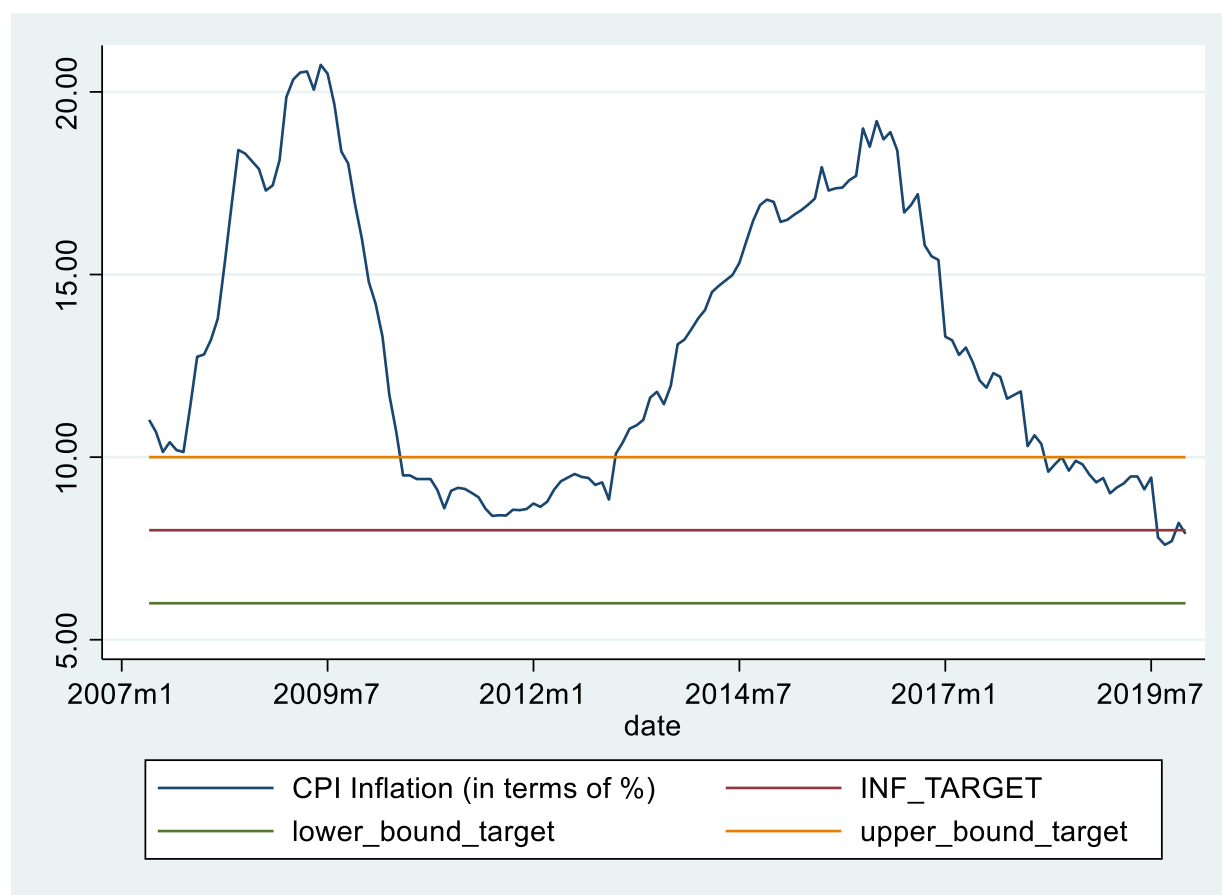


Figure 3. 2: A graph of Inflation Rates with the target inflation and symmetric bands.

Source: Bank of Ghana Time Series Data

Figure 3.2 depicts the actual inflation rate from 2007 compared to the official inflation target rate of 8% when Inflation Targeting was implemented. Apart from 2011, 2012, 2018, and 2019, inflation has been greater than its target for most of the period. This demonstrates how tough it was to meet the target and how tough it has been to meet targets in general. In addition, the Bank of Ghana's key monetary policy instrument, the Monetary Policy Rate (MPR), should be scrutinized for inflation performance. From 2002 to 2019, the connection between inflation and MPR is seen in Figure 3.

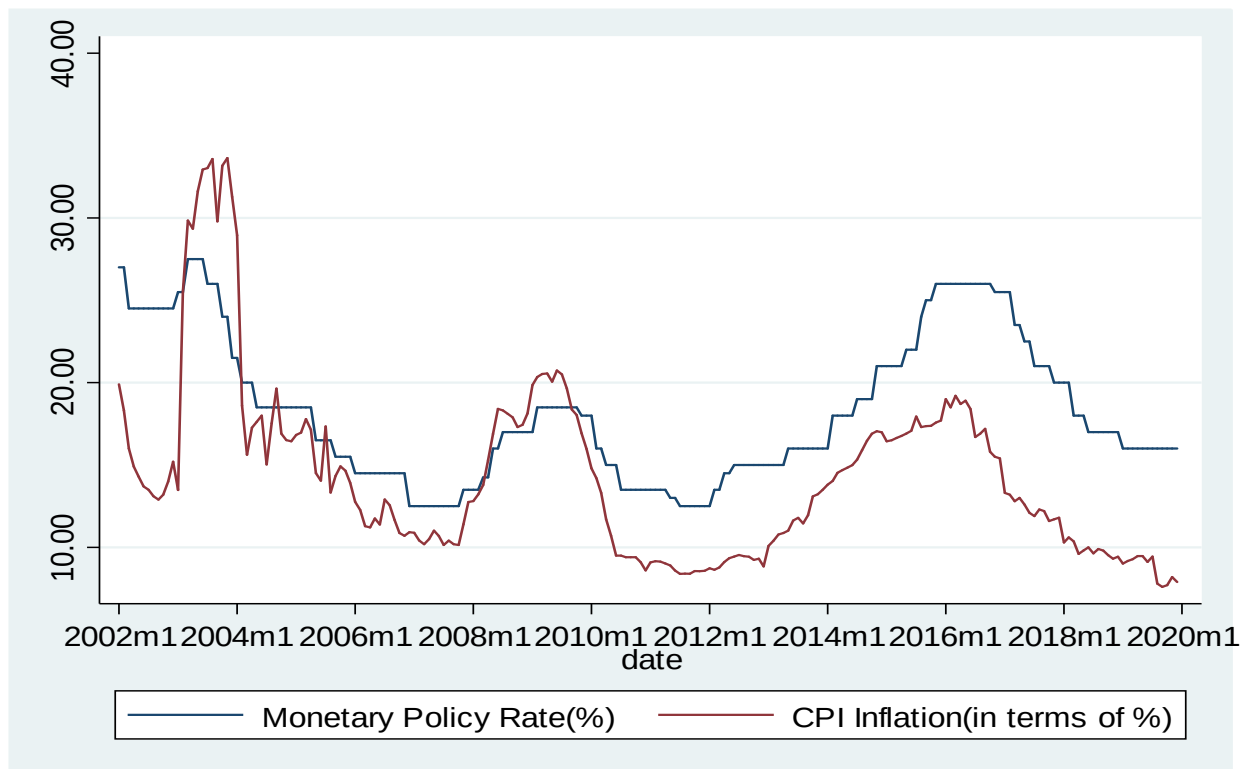


Figure 3. 3: A graph of Inflation and Monetary Policy rates since the adoption of the Inflation targeting framework

Source: Bank of Ghana Time Series Data

A historical plot of inflation and the monetary policy rate is shown in Figure 3. A direct relationship exists between the variables, implying the effectiveness of the Bank of Ghana's policies. The MPR and inflation appear to move in tandem. However, a more notable aspect is the proclivity of the MPR to lower inflation, indicating the policy's effectiveness considering the policy's stated objective of combating inflation. Others, on the other hand, see the MPR in terms of its influence on lending rates, which have not been particularly strong, leading to the conclusion of the ineffectiveness of monetary policy. The MPR and its influence on lending rates are not the subjects of this research.

3.3 Inflation and Monetary Policy Rate (MPR)

The MPR is an essential instrument for Ghana's Central Bank. The Central Bank must evaluate how to adjust the MPR from time to time to keep inflation under control. As previously stated, changes in the MPR should influence commercial bank lending rates, primarily through the interbank rate. It is on this basis that many observers deem monetary policy useless.

According to Kovanen (2011), many of these indicators gradually respond to the policy rate. Inflation and MPR have a direct link, as seen in Figure 3. On this basis, it may be claimed that, because monetary policy aims to achieve lower and stable inflation, the policymaker predicts inflation levels and adjusts the policy rate appropriately, resulting in the correlation. Hence as the pattern indicates a direct link, it implies that the policy rate influences inflation, implying that monetary policy is effective after all.

In his analysis of Ghana's historical inflation performance, Kwakye (2010) argues that inflationary pressures were triggered by the formation of the Central Bank, which necessitated the conduct of its monetary policy independent of other British colonies. As a result of its continued funding of budget deficits, the Central Bank has become a source of inflation. Because of their capacity to

control fiscal deficit financing, Ghana is reported to have considerably higher inflation rates than other francophone comparable nations.

Ocran (2007) believes that the period directly after independence (1957 to 1964) had moderate inflation, averaging around 8% per year, steadily rising to about 23% per annum from 1964 to 1966. The apparent worsening in inflation performance was part of a broader macroeconomic performance deterioration (Fosu & Aryeetey, 2007). The first stabilization program promoted by the IMF, with a devaluation strategy to manage inflation between 1966 and 1972, was required for these occurrences. Although the devaluation program decreased prices below the 1966 era, there was a decline. From 1972 through 1983, a period of political instability saw an inflation mix that peaked at 123% during 1983. The IMF's second stabilization program (Economic Recovery Program (ERP-1983)) helped lower inflation from 123 to 40 percent, together with high agricultural production.

Despite the appearance of inflation instability over the years, macroeconomic performance, including inflation, has been consistent since early 2000, with single-digit inflation reported. Kwakye (2012) argues that the low inflation performance of that era was due to a drop in food inflation, a general improvement in macroeconomic management, and the provision of fuel and other utility subsidies.

Food and non-alcoholic beverages accounted for a significant portion of the CPI in 2012 (over 40%). Food sources contribute immensely to Ghana's inflation rate; therefore, the low inflation rate was primarily due to a reduction in food prices rather than monetary policy. Nonetheless, the MPR had impacted inflation.

3.4 Monetary Policy in Ghana

Monetary policy refers to the activities of a regulatory body or central bank in determining the amount or pace of growth of money supply in order to promote healthy economic development, such as price stability, economic growth, the balance of payments equilibrium, and full employment (Amadeo, 2021). This is conducted in Ghana by the Bank of Ghana, which is responsible for implementing monetary policies that promote long-term economic growth by guaranteeing price stability. Since the introduction of the Economic Recovery Program, Ghana's financial system, and therefore its ways of conducting monetary policy, have undergone some changes, while the primary goal of monetary policy remains price stability. Changes in monetary policy instruments, such as the move from direct to indirect monetary measures, are one of them.

3.4.1. Direct Monetary Policy Controls in Ghana

Ghana used direct monetary controls to manage monetary policy until around 1983. (Bawumia, 2010). This took the shape of lending limits and interest rate control from commercial banks to the private sector. The credit-control system included the Bank of Ghana giving instructions to commercial banks, instructing them to make resources readily available to productive sectors within the economy, most notably agriculture. Commercial banks were mostly compelled to lend only around 20% to 30% of their money to the private sector during this period. Furthermore, strict reserve requirements were imposed by the central bank. Interest rates were managed by establishing floors and ceilings for lending and deposit rates. Reserve requirements were largely used to justify credit limitations at the time.

The central bank determines money supply growth for a given year based on available inflation and economic growth targets. It proceeds to figure out how to expand credit to grow the money supply. Then, while keeping an eye on their adherence to the criteria, spread the credit to other

commercial banks. At the start of each year, the Bank of Ghana released two policy guidelines: general and specialized guidelines. Credit distribution and interest rate controls by economic sectors were the general principles, while credit limits for each bank were the standards. The Bank of Ghana's Banking Supervision Department sanctioned all banks that did not follow these standards. The ease with which this money management system could be implemented was its main advantage.

However, this system had significant flaws, such as high reserve requirements and credit limitations, resulting in massive accumulated credit levels. Due to the limitations imposed on commercial banks, they could not invest or lend. This created a disincentive for commercial banks to raise further savings from the general people. The limitation also maintained low-interest rates on borrowing, particularly for the government and its institutions, thereby allowing the government to borrow at extremely cheap rates compared to the private sector, lowering its borrowing costs. Negative real interest rates resulted, providing further disincentives to mobilizing savings.

3.4.2. Indirect Control of Monetary Policy in Ghana

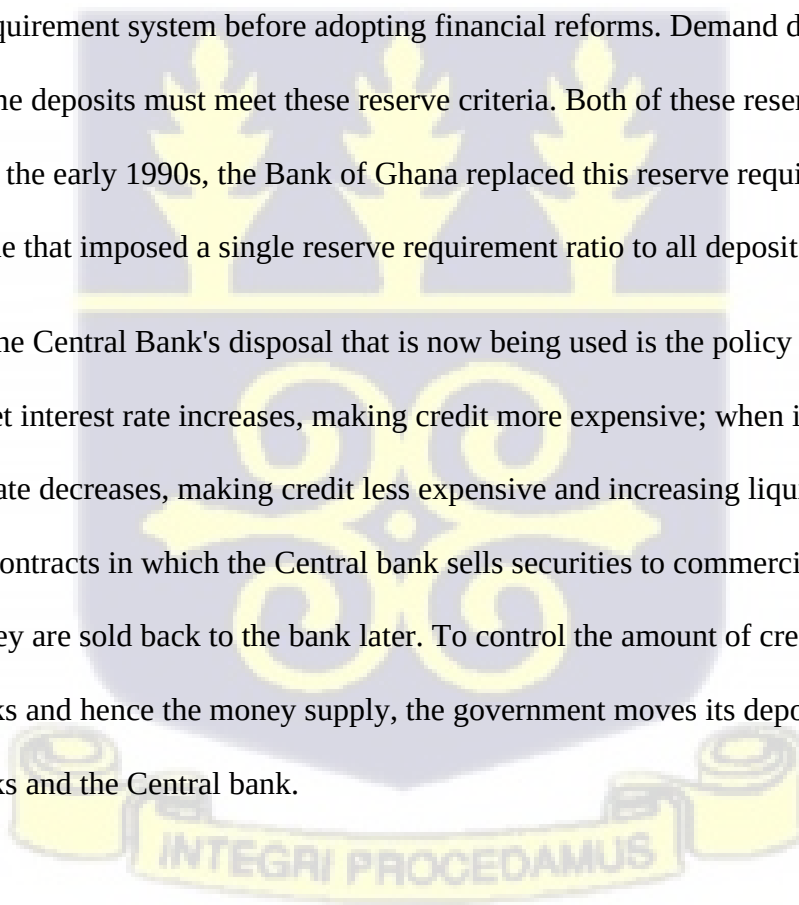
The monetary sector was reformed because of the liberalization process. One crucial shift triggered by liberalization was establishing a market-based monetary management system that relied on indirect means to conduct monetary policy instead of using direct instruments before the liberalization. Under this arrangement, the Bank of Ghana depended significantly on open market operations as a critical instrument.

This is the method by which the Central bank trades government securities based on monetary policy direction. Funds are transferred from the general public and other institutions to the government and vice versa. The monetary base grows or shrinks as a result. During inflationary

periods, the Bank of Ghana sells securities to financial and non-financial institutions and the public to reduce money supply in the economy and drive the inflation rate down. During an economic downturn in the economy, the central bank buys government bonds. This is done to boost the economy by increasing the money supply. Around 1986, massive weekly auctions of government notes were launched as open market activities. The Central bank has also reintroduced its banknotes, which were printed in 1988. The interest payments on these loans had grown unsustainable; therefore, this was finally discontinued.

Another tool used by the Central bank is the Reserve Requirement. Commercial banks are required to keep this percentage of deposits as a minimum. The Bank of Ghana sets this required rate. This tool is faster and more severe than open market activity. The Central bank had a two-tiered reserve requirement system before adopting financial reforms. Demand deposits, savings accounts, and time deposits must meet these reserve criteria. Both of these reserves had distinct reserve ratios. In the early 1990s, the Bank of Ghana replaced this reserve requirement system with a unified one that imposed a single reserve requirement ratio to all deposits.

Another tool at the Central Bank's disposal that is now being used is the policy rate. When this is raised, the market interest rate increases, making credit more expensive; when it is reduced, the market interest rate decreases, making credit less expensive and increasing liquidity. Repurchase agreements are contracts in which the Central bank sells securities to commercial banks on the condition that they are sold back to the bank later. To control the amount of credit granted by commercial banks and hence the money supply, the government moves its deposits between commercial banks and the Central bank.



3.5 Monetary Policy Conduct in Ghana

This section talks about the conduct of monetary policy in Ghana. The Central Bank's main objective is discussed in this section, as well as the members that make up the monetary policy committee and the main instrument used to declare the monetary policy stance.

3.5.1. The mandate of the Bank of Ghana

As outlined in section 3 of the Bank of Ghana Act 2002 (Act 612), aside from the price stability goal, the Bank aids the government's general economic strategy, promotes economic development and growth, ensures the efficient and effective functioning of the banking and financial system, and contributes to the promotion and preservation of financial stability.

3.5.2. The Monetary Policy Committee

The Monetary Policy Committee (MPC) was established by the BOG Act 2002, Act 612 as amended, section 27, and is responsible for formulating the Bank's monetary policy. The members of the Monetary Policy Committee are as follows:

1. The Governor
2. Two Deputy Governors
3. the Bank's head of the department in charge of economic research,
4. the Head of the Department in Charge of the Bank's Treasury Operations, and
5. Two external members, who are not employees of the Central Bank and are chosen by the Board, with knowledge and experience related to the Monetary Policy Committee's responsibilities. (*Our Monetary Policy Framework – Bank of Ghana*).

The Monetary Policy Committee, chaired by the Governor of the Bank of Ghana, meets every two months over three days to review current economic circumstances and the inflation forecast.

Following deliberations, the Committee votes on the decision on monetary policy on a one-person, one-vote basis, with each member explaining explicitly and with reasons their preferred conclusion. In cases where the Committee's position is not obvious, the ultimate decision is made by consensus. The Committee's meeting dates are announced on the Bank's website at the beginning of each year to offer market clarity.

The policy rate is the MPC's primary instrument. This rate indicates the direction in which the economy is going concerning inflation and other economic factors. A decrease in the policy rate indicates that the central bank is conducting an expansionary monetary policy, while a rise in the policy rate indicates that the central bank is conducting a contractionary policy.

The MPC analyzes the macroeconomic indicators of the economy at each meeting before establishing the policy rate and how new rates, whether lower or higher, would impact these macroeconomic indicators and the economy in general. The Committee considers statistics and other reports on banking, fiscal policy, and the real economy. These sectors will help the committee determine how the policy rate should adjust. The MPC gives the monetary sector special attention. This is because there is a clear link between money growth and inflation.

3.6 The Inflation Targeting Framework in Ghana

Before adopting inflation targeting, Ghana transitioned from a controlled monetary policy framework to a monetary aggregate system. Until 1983, the credit-control system was in place (Bawumia, 2010). The economy's money supply was established with inflation as the main objective and growth as a secondary goal. The economy's domestic credit was utilized to meet the specified money supply goal. The government share of the domestic credit was then decided using the Public Sector Borrowing Requirements (PSBR), with the rest going to the private sector. The commercial banks then split up the private sector part of the domestic credit.

Banks were forced to set restrictions on how much money they might lend to specific industries. This was founded on the idea that certain industries were essential compared to others in contributing to the economy's development. This monetary strategy was eventually abandoned owing to its failure to meet specified inflation goals. During this time, Ghana had some of its highest inflation rates, with inflation reaching as high as 123% in 1983. This was primarily due to exceeding the domestic credit limit, which was often exceeded by the government (Kwakye, 2012). The inflation goals were jeopardized as a result.

The monetary aggregates also targeted the money supply to attain inflation targets. In 2006, the usage of the monetary aggregates targeting framework ended. The Open Market Operation (OMO) replaced domestic credit as the operational instrument under this policy regime. The central bank sold and bought treasury securities as part of OMO. Treasury security sales were used to take care of surplus liquidity during times of excess liquidity. The central bank sold treasury securities when it needed to increase liquidity in the economy. Treasury securities were primarily offered in Ghana to mop up excess liquidity in the economy because of significant deficit financing (Kwakye, 2012). OMO, on the other hand, faced certain difficulties. As the government turned to direct funding from the central bank, OMO funds made their way back into the budget, undermining the primary objective of OMO. As a result, inflation goals were missed. Inflation was also high during this time, though not as high as during the controlled regime. During this time, inflation peaked at about 60% in 1995. As a result, the inflation-targeting framework was implemented. Ghana's inflation goal is regularly adjusted by the Bank of Ghana's policy rate target. Open market operations are used to keep the interest rate at a certain level. The rate is maintained at this level for as long as necessary to accomplish the goal of price stability which may last months. The Monetary Policy Committee reviews this rate regularly. This analysis is carried out in reaction to

different macroeconomic variables to provide a more accurate prediction of their developments to meet the inflation target rate.

The Bank of Ghana's primary goal has been to attain and maintain a single-digit inflation rate since the official introduction of inflation targeting in May 2007. Even though inflation targeting had been implemented in 2002, a formal statement was required to hold the Bank of Ghana responsible for preserving the price stability goal of the Bank of Ghana Act 2002. Transparency is an essential component of inflation targeting's success. This is guaranteed through the Monetary Policy Committee's procedures, which include frequent press conferences where the media may ask questions about the Committee's choices and the direction where the Committee intends to steer the economy. The Monetary Policy Committee's reports, made public after their meetings, also contribute to a more transparent process since anybody may read them and learn about the Committee's procedures.

Inflation expectations have fallen by approximately 100 percentage points since the introduction of inflation targeting (Opoku-Afari, 2005). However, there have been a few occasions when inflation expectations have risen. In quarter two of 2002, one such instance occurred. This was due to Ghana's expected gasoline price increases. This pattern lasted until the price hikes were revealed in early 2003. The Bank of Ghana raised the policy rate in 2003, which helped to limit the rise in expectations and eventually led to a decrease in expectations of inflation (Opoku-Afari, 2005).

Market participants were more confident in the ability of the Bank of Ghana to manage shocks because of this properly. Inflationary expectations fell even more as a result. Liberalization of the petroleum industry occurred in February 2005, resulting in higher adjustments in gasoline prices, although this had little impact on expectations due to a general downward trajectory in inflationary expectations. According to Opoku-Afari (2005), a decrease in inflationary expectations leads to a

decrease in inflation. The lower inflation numbers achieved during the inflation targeting era relative to the period of monetary aggregates demonstrate this. In 2011, inflation reached a low of around 9%.

According to (Bawumia, 2010), inflation targeting has delivered the best results in major macroeconomic indicators since attaining independence. He also claims that the inflation targeting framework has made the economy more resilient to external shocks than the regulated and monetary aggregate regimes.

3.5.1. Monetary Sector Developments

Ghana's financial system is reasonably advanced. Although this might be the case now, it was not always the case in the 1960s and 1970s, when governments utilized these banks to fund their programs. Some banks suffered losses due to the government's usage of the banks. As a result, the banking system had to be reformed to improve the efficiency and effectiveness of the monetary policy.

Treasury notes were first sold weekly as a result of this. The Central bank has likewise switched from using direct to indirect instruments in its monetary policy management. Due to the negative consequences of the financial repression that was in place at the time, the financial sector adjustment program was implemented to help retool the financial system from 1988 to 1990 by expanding savings mobilization, continuing to develop the money and securities market, and improving credit allocation system efficiency. In 1989, new banking legislation was enacted to improve the financial sector.

As a result of the new legislation, banks are required to have a minimum capital requirement of 6% of net assets, with the Central bank having the power to alter this number. The second stage of

the financial sector adjustment program, which was a modified version of the previous phase, was implemented between 1990 and 1991. In 1993, legislation governing non-bank financial institutions also was passed. Several legislations were enacted to develop the financial system, simplify transactions within the sector, and strengthen the Bank of Ghana in liberalizing the financial sector. The payment system act and the financial system act were among these legislations. Around 2000, the procedures for passing legislation into law began, and the Ghanaian financial sector experienced significant changes.

From mid-2017 to end-December 2018, the Bank of Ghana undertook a banking sector clean-up, recapitalization, and other regulatory changes as part of its duty to enhance the financial system's safety, stability, and soundness to support economic growth. The minimum capital requirement for banks was increased from GHS 120 million to GHS 400 million, with banks being given until 2018 to achieve it. As a result of the increased minimum capital requirement, several banks merged, while nine others failed to fulfil the requirement by the deadline. The clean-up of the financial sector affected not just banks but also savings and loan businesses, microfinance organizations, and investment managers throughout the country. About 23 distinct savings and loan institutions, 386 microfinance firms, and 53 fund managers went bankrupt between 2017 and 2018.

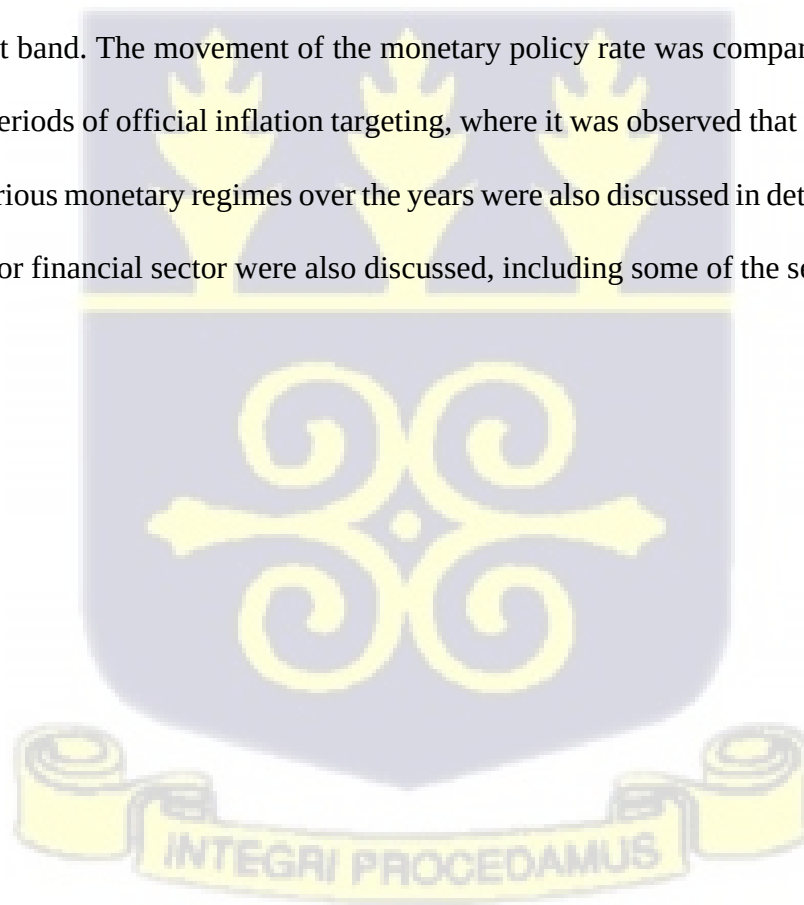
According to the Banking sector report (2020), expanding the banking sector is the first key criterion for evaluating the reform process. Although the recapitalization process reduced the number of banks from 33 in December 2016 to 23 in December 2018, the industry's balance sheet indicators indicated higher growth in the main performance matrix. Total assets, a fundamental indicator of the banking sector's size, nearly doubled in 2019, rising to 22.8% from 12.3% in 2018, thanks in part to the continuous increase in deposits since 2017, as well as the fast growth in 2019.

Deposit growth increased from 12.7% to 17.3% in 2018 and 22.2% in 2019, reflecting the banking sector's restored and rising confidence due to the reforms.

Again, the report indicated that the banking sector being repositioned to assist economic growth through intermediation was another beneficial outcome of the reforms. Since the changes went into force, credit growth has accelerated significantly. In December 2019, banking sector credit grew to GH45.2 billion, up from GH36.5 billion as of December 2018. Growth in new advancements rebounded substantially in 2019, rising to GH29.7 billion from GH23.3 billion in 2018. The expansion of credit was widespread, affecting all economic sectors.

3.7 Conclusion

This chapter considered the inflation performance over the years and the performance of inflation against the target band. The movement of the monetary policy rate was compared to the inflation rate during the periods of official inflation targeting, where it was observed that they moved closer together. The various monetary regimes over the years were also discussed in detail. Developments in the monetary or financial sector were also discussed, including some of the sector cleanups and the effects.



CHAPTER FOUR

METHODOLOGY AND DATA SOURCES

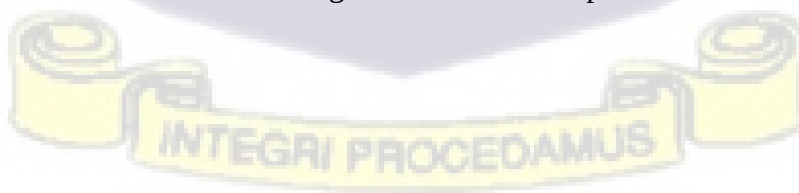
4.0 Introduction

This chapter discusses the econometric approach used to model the monetary policy rule in Ghana and how all investigations will be conducted through the appropriate test of significance and diagnostic tests.

4.1 Methodology

This study first investigates whether the Taylor rule augmented with real exchange rates will better describe monetary policy conduct than just the baseline rule Taylor propounded (Taylor, 1993). Again, this study seeks to investigate if there is a case for nonlinearities in the monetary policy conduct of Ghana as evidence for asymmetry or nonlinearities has been found in monetary policy conduct in other countries hence motivating us to take a critical look at the linearity implied by the Taylor rule.

This study will utilize regression analysis to investigate the role of exchange rates in the Taylor rule as compared to the traditional Taylor rule and investigate possible asymmetric or nonlinear monetary policy conduct. The Ordinary Least Squares is known as the Best Linear Unbiased Estimator (BLUE). However, it may not be used since it requires stationarity of all variables used since when the variables utilized are not stationary, we are prone to spurious regression, which might lead us to conclude there is some significant relationship but rather due to the presence of unit root.



This study, therefore, employs the Autoregressive Distributed Lag (ARDL) model proposed by Pesaran et al. (2001) and the Nonlinear Autoregressive Distributed Lag (NARDL) model propounded by Shin et al. (2014).

4.1.1 Autoregressive Distributed Lag (ARDL) Model

The ARDL modelling approach, based on the Ordinary Least Square (OLS) method, may represent both stationary and non-stationary time series. It may be estimated as least squares regressions utilizing the lags of the dependent and independent variables because it is a least squares-based model.

The ARDL model helps us estimate a linear relationship between the dependent and the independent variables, including lags of both the dependent and independent variables. These lags are selected by information criteria such as the Akaike Information Criteria and Schwarz Information criteria, among others. Optimal lag-length selection is essential since it helps rid the estimated model of any serial correlation. For this study, the Akaike Lag Selection Criteria was utilized since the Akaike Information criteria gave the least values for each of the variables. Again, the Akaike Information Criteria and the Schwarz Bayesian Information are more popularly used; Yang (2005) argues that though the BIC selects the best model when the sample size approaches infinity and the actual population relationship is a candidate to be selected, the AIC typically selects models with a lower mean squared error as compared to BIC in finite samples. An automatic lag selection based on the Akaike Information Criterion by EViews was used in selecting the lag orders for the various variables.

The estimation results will be presented in the sample period from May 2007 to December 2019. The reasoning is that though from 2002, price stability was the central bank's main objective, there

was an official commitment towards inflation targeting in May 2007. Hence, the research will consider estimates from May 2007 till December 2019 to observe how monetary policy has been conducted. Again, though the ARDL is used, much discussion will not be on the compact form of the ARDL since it combines long-run and short-run effects. Hence, the error correction reparameterization will be used in discussing the results to determine how the Central Bank conducts monetary policy; the long-run relationship is essential in informing us though the short-run estimates are also critical in informing us of the Central Bank's behaviour in the short run.

Several factors support the employment of the ARDL Modeling approach in this investigation. For starters, it aids in the avoidance of non-stationarity issues that are common in time-series data. Second, due to the bounds test and error correction re-modelling that may be obtained, it would be possible to explore long-run connections between variables. Also, since there is frequently a delay between economic activity and a result due to time lags, the ARDL technique allows for appropriate lags to match the data generation process. Finally, Pesaran et al. (2001) assert that it is acceptable for small or finite sample sizes.

Using the ARDL model for this study, a baseline Taylor rule will be estimated first and then juxtaposed with an exchange rate augmented Taylor rule to see whether exchange rates are considered in the conduct of monetary policy.

4.1.2 Nonlinear Autoregressive Distributed Lags

The Nonlinear Autoregressive Distributed Lag (NARDL), like the ARDL, is also an OLS-based approach to representing econometric relationships. It also involves utilizing some optimal lags of the dependent and independent variables, just like the ARDL. It also helps in estimating a relationship between variables with a mixture between stationary variables and variables with a unit root.

The difference is that the NARDL enables us to capture asymmetric responses in variables the researcher observes to exhibit such behaviour. Variables exhibiting asymmetric responses are broken into partial sums of positive and negative deviations. Hence unlike the ARDL method, where the relationships between variables here are captured in just a symmetric form, the NARDL allows the researcher to observe asymmetric responses.

The NARDL also carries all the advantages of the ARDL since it is based on the ARDL. It further gives the researcher the advantages of studying the short-run and long-run asymmetries between variables. The long-run relationships are done through the Bounds-Test approach used in the ARDL. The NARDL as well can be reparametrized into an Error Correction Model. The NARDL can also help the study observe the dynamic multipliers: how the dependent variable moves to equilibrium when there is a shock (positive or negative) in the variable displaying asymmetry.

4.1.3 Model Diagnosis

Using suitable econometric techniques to diagnose models is frequently critical in regression analysis. Model diagnosis entails searching for errors in the specification of the model and issues with variables chosen for their suitability. To diagnose, one might look at the coefficient residual, a measure of stability. The coefficient diagnostic, for example, determines if the estimated coefficient has any limitations that prevent it from being utilized to draw policy conclusions or conduct additional analysis. It also examines whether superfluous variables have been added and whether highly relevant variables have been removed.

Regarding residual diagnosis, one should search for mistakes in the residuals, such as if they are correlated. Again, we must observe and test to see whether these residuals also have a constant variance. The correlation between independent variables must be examined to avoid cases where the independent variables are highly collinear. The stability diagnosis then determines if parameter

estimations, for example, are stable across subsamples of data. All of this aims to achieve a positive outcome that can be confidently defended.

4.2 Specification of Model

The process by which the independent variables influence the dependent variable is described by model specification, which is an important activity in econometric analysis.

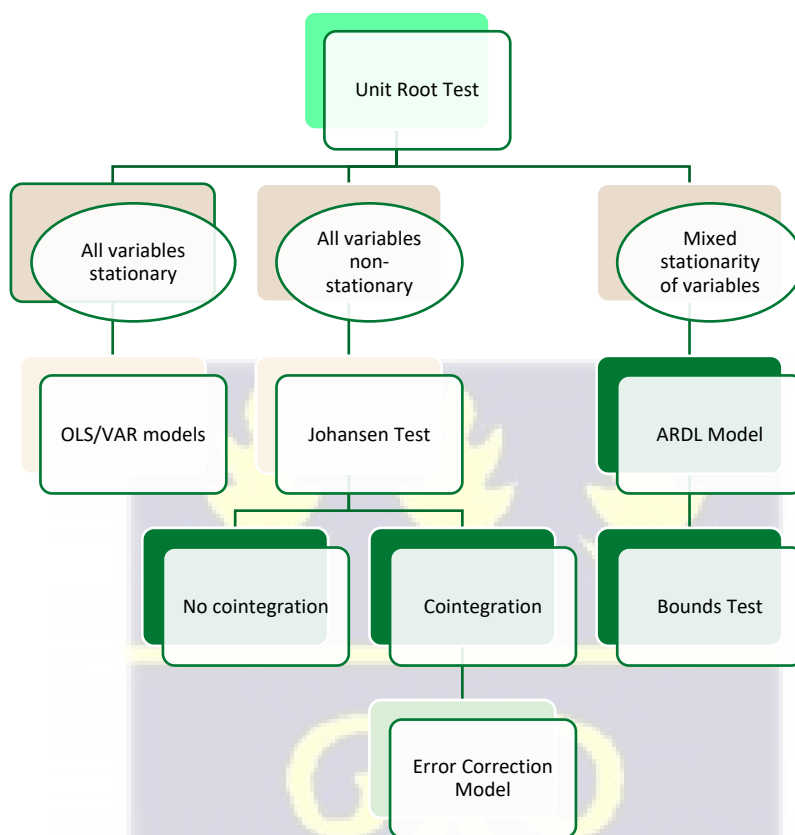


Figure 4. 1: Time series model selection framework

Source: Shrestha & Bhatta (2018)

The dependent variable in each study is usually chosen by a researcher depending on the economic topic of interest and prior understanding of economic theory. Because economic interactions are rarely linear, a researcher may need to model with some flexibility (Pedace, 2013). Since there is a risk of selecting the incorrect specification, it is critical to undertake a model evaluation.

A common modelling approach for time series analysis is shown in Figure Five (5) below. According to the framework, a researcher working with time series data should first check for the stationarity of the variables. Following this widely acknowledged methodology, as a result, all variables in the research were tested for stationarity.

4.2.1 Formulation of General Model

This model is specified as the traditional Taylor rule augmented by inflation. Thus, it is specified below as

$$MPR = F(INF_GAP, OUTPUT_GAP, LREER) \dots\dots\dots (1)$$

Where:

- MPR = Monetary Policy Rate
- INF_GAP = Inflation Gap
- OUTPUT_GAP = Output Gap
- LREER = Log of Real Effective Exchange Rate

Equation 1 above is the functional specification of the monetary policy reaction function in the Taylor rule formulation. The functional form contains real effective exchange to make room for the augmented Taylor rule. Now initially, the traditional Taylor rule is formulated econometrically as follows,

$$MPR_t = \alpha_0 + \alpha_1 INF_GAP_t + \alpha_2 OUTPUT_GAP_t + \epsilon_t \dots\dots\dots (2)$$

Now augmenting Equation 2 with the log of real effective exchange rates, the augmented Taylor rule is specified as,

$$MPR_t = \beta_0 + \beta_1 INF_GAP_t + \beta_2 OUTPUT_GAP_t + \beta_3 LREER + \mu_t \dots\dots\dots (3)$$

The population regression function, represented by equations 2 and 3, is a hypothetical depiction of the inter-relationships among the variables. The variables on the right-hand side of the equation (independent variables) produce a value for the left-hand-side variable, which is then combined with the alphas and betas to determine the amount and level of the effect. $\alpha_0 - \alpha_2$ and $\beta_0 - \beta_3$ are parameters to be estimated in equation 2 and equation 3 above, respectively, to offer an indication of how much each independent variable can impact the dependent variable while the others are held constant.

4.2.2 ARDL Model Specification

As mentioned previously and also by Shrestha & Bhatta (2018), the ARDL model is used when we have a mix of stationary and nonstationary variables (that is, a mix of I(0) and I(1) variables). It cannot be applied to variables integrated of order two (2) and above. The ARDL is usually estimated in a compact form and can be reparametrized into an unrestricted error correction form or conditional error correction form, as referred to by (Pesaran et al., 2001). In compact form, the ARDL is specified as

$$MPR_t = \alpha_0 + \sum_{i=1}^p \alpha_i MPR_{t-i} + \sum_{i=0}^q \beta_i INF_GAP_{t-i} + \sum_{i=0}^r \gamma_i OUTPUT_GAP_{t-i} + \mu_t \dots (4)$$

Equation 4 above represents the traditional Taylor rule which accounts for interest rate smoothing, a prevalent practice by most Central Banks, as discussed previously. Equation 5 represents the Taylor rule that has been augmented to account for the interest rate's effect on monetary policy conduct.

$$MPR_t = \alpha_0 + \sum_{i=1}^p \alpha_i MPR_{t-i} + \sum_{i=0}^q \beta_i INF_GAP_{t-i} + \sum_{i=0}^r \gamma_i OUTPUT_GAP_{t-i} + \sum_{i=0}^s \delta_i LREER_{t-i} + \varepsilon_t \dots (5).$$

Equations 4 and 5 can be reparametrized through the linear transformation $y_t = \Delta y_t + y_{t-1}$ to obtain an Unrestricted Error Correction Model (Nkoro & Aham, 2016). Applying this linear transformation to Equations 4 and 5, the Error Correction Model obtained is as stated below,

$$\Delta MPR_t = \alpha_0 + \sum_{i=1}^p \alpha_i \Delta MPR_{t-i} + \sum_{i=0}^q \beta_i \Delta INF_GAP_{t-i} + \sum_{i=0}^r \gamma_i \Delta OUTPUT_GAP_{t-i} + \sigma_1 INF_GAP_{t-1} + \sigma_2 OUTPUT_GAP_{t-1} - \sigma_3 MPR_{t-1} + \mu_t, \text{ for the traditional Taylor rule and}$$

$$\Delta MPR_t = \alpha_0 + \sum_{i=1}^p \alpha_i \Delta MPR_{t-i} + \sum_{i=0}^q \beta_i \Delta INF_GAP_{t-i} + \sum_{i=0}^r \gamma_i \Delta OPT_GAP_{t-i} + \sum_{i=0}^s \Delta LREER_{t-i} + \sigma_0 INF_GAP_{t-1} + \sigma_1 OUTPUT_GAP_{t-1} + \sigma_2 LREER_{t-1} + \sigma_2 MPR_{t-1} + \varepsilon_t, \text{ for the case where exchange rates augment the Taylor rule. The error correction reparameterization helps us observe the short-run dynamics (characterized by the differenced variables) and the long-run relationships (characterized by the lagged levels variables). However, the Bounds Test must be conducted to ascertain the long-run relationship.}$$

4.2.2.1 Bounds Test

The Bounds Test is conducted to ascertain the long-term relationship between the variables. This test is a joint significance test of coefficients of the lagged levels variables. The hypothesis that the lag level variable coefficients are zero is to be tested. Hence the hypotheses are stated as follows:

$$H_0: \sigma_0 = \sigma_1 = \dots = \sigma_k \text{ (null hypothesis of no long run relationship)}$$

$$H_1: \text{There are some } \sigma_k \neq 0 \text{ (alternate hypothesis of long run relationship)}$$

where k indicates the number of lagged level variables. The F-statistic is used to test the hypothesis (Wald test). Regardless of whether the variables in the system are I(0) or I(1), the distribution of

these F-statistics is non-standard. Pesaran et al. (2001) provide the crucial values of the F-statistics for various numbers of variables (K) and whether the ARDL model has an intercept or trend. Two sets of critical values are shown. One set assumes that all the variables in the ARDL model are $I(0)$ (that is, lower critical bound, which assumes that all the variables are $I(0)$, implying that there is no cointegration among the underlying variables). The other set assumes that all the variables are $I(1)$ (that is, upper critical bound, which assumes that all the variables are $I(1)$, implying that there is cointegration among the underlying variables). A band for each application covers all potential variables categorising into $I(0)$ and $I(1)$. If the F-statistic is above the critical values for the $I(1)$ set, then we conclude there is cointegration. If the F-statistic is below the critical values for the $I(0)$ band, then we conclude there is no cointegration; hence, only the short-run dynamics are to be considered. When the F-statistic is between the $I(0)$ and $I(1)$ band of critical values, the test is inconclusive and will depend on the nature of the variables.

4.2.3 Nonlinear ARDL (NARDL) model specification

The NARDL, like the ARDL, is also an Ordinary Least Squares (OLS) based model. It, too, is applied when we obtain a mixture of $I(0)$ and $I(1)$ variables (mixed stationarity). It cannot also be applied to variables integrated of order two or higher. Like the ARDL, it can also be reparametrized into an error correction model (Shin et al., 2014). The NARDL helps us assess how positive and negative changes influence the dependent variable. Thus, as the ARDL helps us look at time series analysis symmetrically, the NARDL helps us assess time series relationships asymmetrically. It can be specified in the compacted form and remodelled into the error correction form. Shin et al. (2014) proposed the NARDL, which incorporated short-run and long-run asymmetries through positive and negative partial decompositions of independent variables or factors known to have an asymmetric influence on a dependent variable. Thus, for a variable, say

$y_t, y_t = y_t^+ + y_t^- + \mu_t$, where y_t^+ represents positive partial sums of y_t and y_t^- represents negative partial sums of y_t .

Mathematically, these partial sums are decomposed as follows:

$y_t^+ = \sum_{k=1}^t \Delta y_k^+ = \sum_{k=1}^t \max(\Delta y_k, 0)$ and $y_t^- = \sum_{k=1}^t \Delta y_k^- = \sum_{k=1}^t \min(\Delta y_k, 0)$. These partial sums help incorporate positive and negative deviation effects on the dependent variable. Hence Equation 5 is respecified in the compact form as,

$$\begin{aligned} MPR_t = & \alpha_0 + \sum_{i=1}^p \alpha_i MPR_{t-i} + \sum_{i=0}^{q_1} \beta_i^+ INF_GAP_{t-i}^+ + \sum_{i=0}^{q_2} \beta_i^- INF_GAP_{t-i}^- + \\ & \sum_{i=0}^{r_1} \gamma_i^+ OUTPUT_GAP_{t-i}^+ + \sum_{i=0}^{r_2} \gamma_i^- OUTPUT_GAP_{t-i}^- + \sum_{i=0}^{s_1} \delta_i^+ LREER_{t-i}^+ + \\ & \sum_{i=0}^{s_2} \delta_i^- LREER_{t-i}^- + \varepsilon_t \dots \dots \dots (6) \end{aligned}$$

In the error correction form, Equation 6 is remodelled as

$$\begin{aligned} \Delta MPR_t = & a_0 + \sum_{i=1}^p a_i \Delta MPR_{t-i} + \sum_{i=0}^{q_1} b_i^+ \Delta INF_GAP_{t-i}^+ + \\ & \sum_{i=0}^{q_2} b_i^- \Delta INF_GAP_{t-i}^- + \sum_{i=0}^{r_1} c_i^+ \Delta OUTPUT_GAP_{t-i}^+ + \sum_{i=0}^{r_2} c_i^- \Delta OUTPUT_GAP_{t-i}^- + \\ & \sum_{i=0}^{s_1} d_i^+ \Delta LREER_{t-i}^+ + \sum_{i=0}^{s_2} d_i^- \Delta LREER_{t-i}^- + \rho MPR_{t-1} + \varphi_0^+ INF_GAP_{t-1}^+ + \\ & \varphi_0^- INF_GAP_{t-1}^- + \varphi_1^+ OUTPUT_GAP_{t-1}^+ + \varphi_1^- OUTPUT_GAP_{t-1}^- + \\ & \varphi_2^+ LREER_{t-1}^+ + \varphi_2^- LREER_{t-1}^- + \mu_t \dots \dots \dots (7) \end{aligned}$$

To test the long-run relationship (cointegration), like in the ARDL, we can use the Bounds test to determine the joint significance of the long-run coefficients.

4.2.3.1 Test of Asymmetry

After obtaining coefficients describing the short-run dynamics and long-run levels relationship, we can test the validity of asymmetry by comparing and testing the coefficients of the positive and negative deviations in the short and long run using the Wald test.

For the short-run asymmetry, we test the null hypothesis of equality in positive and negative deviation short-run coefficients against the alternate hypothesis that they are not equal. That is,

$H_0: \sum_{i=0}^{q_1} b_i^+ = \sum_{i=0}^{q_1} b_i^-$ (Null hypothesis of equality of short-run positive and negative deviations or short-run symmetry)

$H_1: \sum_{i=0}^{q_1} b_i^+ \neq \sum_{i=0}^{q_1} b_i^-$ (Alternate hypothesis of asymmetry of short-run positive and negative deviations or short-run asymmetry).

For long-run asymmetry, we test the null hypothesis of equality in coefficients of positive and negative deviations against the alternate hypothesis that they are unequal. That is, from the levels relationship,

$H_0: -\varphi_i^+ / \rho = -\varphi_i^- / \rho$, Null hypothesis (long run symmetry)

$H_1: -\varphi_i^+ / \rho \neq -\varphi_i^- / \rho$, Alternate hypothesis (long run asymmetry), $i = 1, 2 \dots k$

Lastly, the adjustment patterns from initial equilibrium to new equilibrium following an economic disturbance capture adjustment asymmetry. That is, how the model adjusts towards a new equilibrium because of a positive or negative shock in the independent variables.

4.3 Sources and Type of Data

Time series data is utilized in the study. A time series is a collection of observations that are organized in space or time. Time-series econometrics has been a fast-growing discipline, with many new concepts emerging regularly. Time series analysis highlights significant aspects of a data series, such as trends, seasonality, cyclicity, and other characteristics. Due to this study's analysis, secondary data is sourced from various sources for estimation. These sources are the Bank of Ghana, the Ghana Statistical Service, and the International Financial Statistics.

One central tenet of Inflation targeting is consistently seeking to achieve lower and stable inflation rates. As Svensson (1999) said, inflation targeting can be considered a commitment to a systematic and rational monetary policy to a greater extent than any other monetary policy regime. He also said that instrument rules serve as a frame of reference for the actual policy and its evaluation. Taylor (1993) estimated an interest rate rule (popularly known as the Taylor rule), where he found out that the Feds Funds rate was described by the inflation gap and the output gap.

As such, the variables considered for this study are the Monetary Policy rate set by the Bank of Ghana, the Inflation gap, and the Output gap. The variable Real Effective Exchange rate is also considered to explore its effects on the monetary policy conduct of Ghana. The post-inflation targeting era from 2000 to 2019 is considered in this study as it is this period where price stability was the focus of the Central Bank as such, the tendency to adhere to policy rules.

Table 4. 1 Variable Description and Source of Data for these variables

VARIABLE	ABBREVIATION	SOURCE
Monetary Policy Rate (monthly %)	MPR	Bank of Ghana
Inflation Gap	INFL_GAP	Inflation variable from Bank of Ghana
Output Gap	OUTPUT_GAP	Composite Index of Economic Activity variable from Bank of Ghana
Real Effective Exchange Rate	REER	International Financial Statistics

Source: Author's compilation with Bank of Ghana, Ghana Statistical Service, and International Financial Statistics Data

However, the estimates of the Taylor rules will be made considering the sample period where there was an official announcement of inflation targeting as the framework for monetary policy, from May 2007 to December 2019. The monthly data is collected from various sources since the Monetary Policy Committee meets bi-monthly (every two months) to decide the monetary policy rate.

Table 4.1 shows a brief description of the variables used in this study and their abbreviations as used in the study. The following is a description of what the variables mean in the study:

1. Monetary Policy Rate (MPR): This is the dependent variable used in the estimation. It is the policy instrument primarily relied on to declare the stance of the Central Bank in its quest to achieve low and stable inflation rates. It is set by the Monetary Policy Committee of the Bank of Ghana.
2. Inflation Gap: This is one of the explanatory variables utilized. It is generated as the difference between the current and target inflation rates of 8%. With 2018 as the base year, the inflation rate is measured by the year-on-year percentage change in the consumer price index (CPI).
3. Output Gap: The difference between an economy's actual output and its potential output is known as the output gap. Potential output is obtained using the Hodrick-Prescott Filter as used by Caporale et al. (2018) to detrend output. The smoothing parameter used by the Hodrick-Prescott filter was selected following the work of Ravn & Uhlig (2002), who proposed a smoothing parameter of 129,000 for data on a monthly frequency. Since the analysis is done monthly, the Bank of Ghana Composite Index of Economic Activity (Real) (CIEA) is used to proxy output. This is because the Central Bank measures the CIEA to judge the country's economic activity level.

4. Real Effective Exchange rates: The real effective exchange rate is the weighted average of a country's currency against an index or basket of other major currencies (REER). The weights are determined by comparing a country's relative trade balance to the trade balance of every other country in the index. When a country's REER rises, its exports become more expensive while its imports become cheaper. This variable will be logged when it is utilized for analysis.

4.4 Stationarity and Unit Root Tests

Understanding the behaviour of the series being used in time series analysis is crucial. Indeed, a suitable regression model may be created if the main properties of time series data are appropriately recognized and managed. The analysis of such data can also disclose the pattern of connections between variables of interest, which can help to prevent misleading or incorrect regression.

A time series dataset might be non-stationary or stationary. A statistical equilibrium or dispersion about a constant mean value defines a stationary series (White & Granger, 2011). When a series is mean reverting throughout time or in the long term, it is said to be stationary. Makridakis (1976) agrees, saying that working with stationary series has the benefit of being time-independent statistical characteristics.

Non-stationarity is prevalent in most macroeconomic variables and hence is integrated of some order. Most series are difference stationary rather than at their levels, as differencing filters out the unstable processes. Difference stationary processes are also known as integrated processes, and they are called integrated processes of order d , or $I(d)$, where d is the number of times the variable must be differenced to make it stationary.

There are several methods for assessing whether or not a series is stationary, including formalized and graphical tests, with the former being the more objective approach. Some formalized tests compare the null hypothesis of the existence of unit root against an alternative hypothesis of stationarity of the variable, which might contain a deterministic linear trend, a non-zero mean term, and perhaps seasonal dummy factors. In the case of the second set of tests, an AR process or nonparametric techniques are used to describe the stochastic component. The third type of test, the KPSS, takes a different approach to unit root testing by contrasting the null hypothesis of stationarity with the unit root alternative. The Phillips-Perron (PP), Augmented Dickey-Fuller (ADF), as well as the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are used extensively in research. In this study, the ADF test will be used, and the results for the PP test will be compared to the ADF test. According to Phillips & Perron (1988), the PP test is used to support ADF since it is nonparametric regarding nuisance parameters and therefore allows for the investigation of a wide range of time series models with unit roots. When the time series has moving average components, it has an advantage over the Augmented Dickey-Fuller test.

The unit root/stationarity test on the variables employed in this study found that variables have mixed stationarity, which contains a mix of $I(0)$ and $I(1)$ variables, indicating that the ARDL modelling technique was applied correctly.

4.5 Serial Correlation

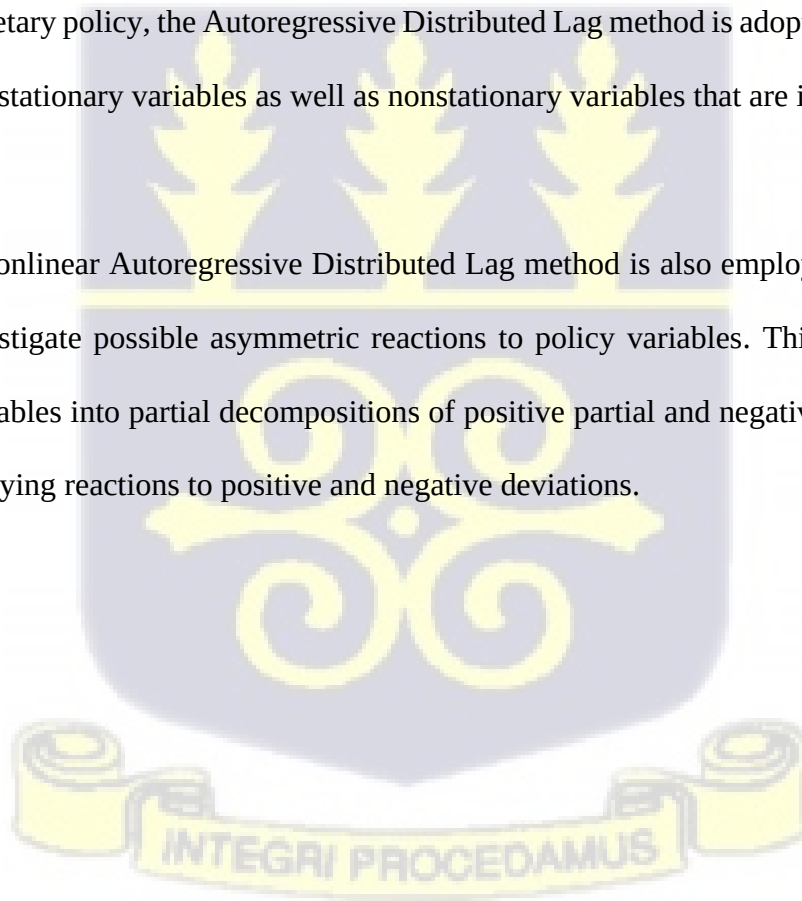
For time-series data, serial correlation is a significant concern. When error terms from different periods are correlated, serial correlation occurs. As a result, serial correlation may cause issues with estimate efficiency, understatement of variance, and overstatement of R^2 , invalidating the t and F tests. This may lead to rejecting certain hypotheses that should not be discarded. Using EViews 12 software, this study uses the Breusch-Godfrey LM test. The LM test's null hypothesis

is that there is no serial correlation up to lag order p , where p is the researcher's lag order. The $\text{Obs} \times R\text{-squared}$ value and its probability are used to interpret the test. The Breusch-Godfrey Lagrange Multiplier (LM) test for serial correlation best suits models that include the dependent variable. This test belongs to the Lagrange Multiplier (LM) test family of asymptotic tests and is suitable for both the ARDL and Nonlinear ARDL Models.

4.6 Conclusion

This chapter discussed the theoretical models formed in detail and then developed an econometric model to be estimated. The variables used in the study are described, and the respective sources are provided. The estimation method, appropriate tests, and model diagnostics are also discussed in this chapter. In analyzing the short-run and long-run behaviour of the Central Bank in conducting monetary policy, the Autoregressive Distributed Lag method is adopted as it helps with the treatment of stationary variables as well as nonstationary variables that are integrated of order one.

Secondly, the Nonlinear Autoregressive Distributed Lag method is also employed and discussed in detail to investigate possible asymmetric reactions to policy variables. This technique helps break down variables into partial decompositions of positive partial and negative partial sums, as such aids in studying reactions to positive and negative deviations.



CHAPTER FIVE

DISCUSSION OF RESULTS

5.0 Introduction

This section presents all the results from the various statistical and econometric methods utilized in the study in line with the objectives stated in the first chapter.

5.1 Results from Descriptive Statistics

These include summary results of the key variables used in the study and look at the measure of association between these variables.

5.1.1 Summary Statistics

This section presents results on the summary statistics of variables used in the study. The summary looks at the mean, median, maximum, minimum, skewness, kurtosis, Jacque-Berra test of normality, sum, and the sum of squared deviations.

Table 5.5 gives summary statistics of variables used in the study. In total, there were 216 observations for all the variables. It is observed that from January 2002 to December 2019, on average (mean), the inflation rate was 14.326%, the inflation gap was 6.326%, the real effective exchange rate was 88.621 index points, output was 375.52 index points, the monetary policy on average was 18.275%, and the output gap was very negligible at $6.92 \times 10^{-12}\%$. Inflation had a median value of 13.26%, with an inflation gap having a median of 5.26%, while the median real effective exchange rate was 92.82 index points, with the median output and output gap at 365.8602 index points and -0.000535% , respectively and the monetary policy rate had a median value of 17%. During this period, inflation was highest at 33.63% and lowest at 7.6%, which meant that the inflation gap was highest at 25.63% and lowest at -0.4% .

Table 5. 1 Summary Statistics

	INFL	INFLGAP	REER	OUTPUT	OUTPUT_GAP	MPR
Mean	14.33	6.33	88.62	375.52	0.00	18.28
Median	13.26	5.26	92.82	365.86	0.00	17.00
Maximum	33.63	25.63	113.33	695.57	0.13	27.50
Minimum	7.60	-0.40	54.47	126.65	-0.10	12.50
Std. Dev.	5.40	5.40	15.05	162.90	0.04	4.37
Skewness	1.60	1.60	-0.23	-0.01	0.20	0.61
Kurtosis	6.12	6.12	1.82	1.53	3.24	2.19
Jarque-Bera	179.08	179.08	14.48	19.40	1.94	19.05
Probability	0.00	0.00	0.00	0.00	0.38	0.00
Sum	3094.40	1366.40	19142.12	81112.23	0.00	3947.50
Sum Sq. Dev.	6264.64	6264.64	48716.53	5705580.00	0.34	4113.24
Observations	216.00	216.00	216.00	216.00	216.00	216.00

Source: Author's Computation

The real effective exchange rate achieved a maximum of 113.3259 index points within this period while going as low as 54.47051 index points in this period as well. Output and output gap was 695.57 index points and 0.126516%, respectively, at their highest within this period, while they were 126.6533 index points and -0.104963% at their lowest within this period. The monetary policy rate was highest at 27.5% and was the lowest value at 12.5% during the sample period. Inflation, inflation gap, real effective exchange rate, monetary policy rate, and output all had a standard deviation of 5.3979%, 5.3979%, 15.05286 index points, 4.373937%, and 162.9036 index points, respectively, signifying more dispersion away from their respective mean values. For the output gap, though, the standard deviation was 0.03973, indicating that most of the data were distributed closer to the mean. Now, inflation, inflation gap, monetary policy rate, and the output gap are

skewed right as shown by their positive coefficient of skewness, whiles real effective exchange rate and output are skewed left as shown by a negative coefficient of skewness. The variables inflation, inflation gap, and output gap also displayed a leptokurtic distribution as their kurtosis coefficient was greater than three and the real effective exchange rate, monetary policy rate, and output displayed a platykurtic distribution. From the Jarque-Bera statistic of all the variables, it was observed that all the variables were normally distributed, as can be seen from their p-values exceeding the usual significant level of 5% apart from the output gap, which was not normally distributed.

5.1.2 Correlation Analysis

The table below shows the results from our correlation analysis of the variables used in this study.

Table 5. 2. Correlation Analysis

	INFL	INFLGAP	REER	OUTPUT	OUTPUT_GAP	MPR
INFL	1.00					
INFLGAP	1.00	1.00				
REER	0.09	0.09	1.00			
OUTPUT	-0.41	-0.41	-0.85	1.00		
OUTPUT_GAP	-0.06	-0.06	-0.10	0.10	1.00	
MPR	0.65	0.65	-0.38	0.01	-0.02	1.00

Source: Author's Computation

Now, since the inflation gap is a deviation from a set target of 8%, it will move as inflation moves, giving them the perfect positive relationship they have. We also observe that the inflation gap and monetary policy rate have a moderate positive relationship. Also, output and real effective exchange rates have a strong positive relationship which conforms to the theory as if the real

effective exchange rates appreciate, aggregate demand will fall which will lead to output falling as well.

5.2 Results from Stationarity Tests

The unit root test results on the variables are shown in the table below. An equation of the form $y_t = \rho y_{t-1} + \delta X_t + \epsilon_t$, is used in the Augmented Dickey-Fuller Test. X_t represents exogenous variables, including a case without an intercept, an intercept only, or an intercept and a trend. The levels and first differences of the variables were used to estimate three models.

Table 5. 3. Stationarity Results using ADF Test

Variable	Model	LEVEL		FIRST DIFFERENCE		Conclusion
		t-statistic	p-value	t-statistic	p-value	
MPR	None	0.195560	0.7417	-3.644954	0.0003	Stationary at First Difference
	Intercept	-1.303493	0.6272	-3.641966	0.0060	
	Intercept and Trend	-0.506174	0.9823	-11.88992	0.0000	I (1)
INF_GAP	None	-1.243173	0.1959	-4.346593	0.0000	Stationary at First Difference
	Intercept	-1.915565	0.3245	-4.334312	0.0006	
	Intercept and Trend	-2.119655	0.5303	-4.420962	0.0028	I (1)
OUTPUT_GAP	None	-7.618550	0.0000			Stationary at Levels
	Intercept	-7.587848	0.0000			
	Intercept and Trend	-7.556144	0.0000			I (0)
LREER	None	-1.306107	0.1764	-13.74335	0.0000	Stationary at First Difference
	Intercept	-1.426174	0.5681	-13.86170	0.0000	
	Intercept and Trend	-2.170831	0.5019	-13.83170	0.0000	I (1)

Source: Author's Computation

Based on the results from the Augmented Dickey-Fuller unit root test in Table 5.3, we observe that the output gap is stationary at its levels using the 10%, 5%, and even the 1% significance level whiles monetary policy rate, inflation gap, and the log of real effective exchange rate are stationary

on first differences. Hence, there is a mixture of I (0) and I (1) variables. Therefore, the ARDL and NARDL will be the best modelling approach for this type of data since it is suitable for a mixture of I (0) and I (1) variables and the Bounds test approach helps to test for cointegration. These results, however, are backed up by the Phillips-Perron test due to the weaknesses of the ADF test.

Now the results from the Phillips-Perron test are described in the table below,

Table 5. 4 Stationarity Results using the PP Test

		LEVEL		FIRST DIFFERENCE		
Variable	Model	t-statistic	p-value	t-statistic	p-value	Conclusion
MPR	None	-0.021795	0.6740	-12.63529	0.0000	Stationary at First Difference
	Intercept	-1.581930	0.4893	-12.61663	0.0000	
	Intercept and Trend	-1.101252	0.9247	-12.68120	0.0000	I (1)
INF_GAP	None	-1.107024	0.2427	-9.397048	0.0000	Stationary at First Difference
	Intercept	-1.523859	0.5190	-9.378146	0.0000	
	Intercept and Trend	-1.685913	0.7529	-9.291243	0.0000	I (1)
OUTPUT_GAP	None	-7.664731	0.0000			Stationary at Levels
	Intercept	-7.632313	0.0000			
	Intercept and Trend	-7.601401	0.0000			I (0)
LREER	None	-1.341306	0.1661	-13.65584	0.0000	Stationary at First Difference
	Intercept	-1.426195	0.5681	-13.76288	0.0000	
	Intercept and Trend	-2.286487	0.4383	-13.73617	0.0000	I (1)

Source: Author's Computation

The results from the Phillips-Perron Test agree with that of the ADF test hence obtaining a mix of I (0) and I (1) variables. This, therefore, informs the decision to utilize ARDL and NARDL since they can be used to study short-run and long-run relationships as well as asymmetries both in the short-term and the long term.

5.3 Results from Regression Estimates

In this section, the regression estimates of the Taylor-type rule are presented and, in line with the objectives of this study, are examined if, indeed, augmentation with real exchange rates better describes monetary policy conduct from the Central Bank and investigate possible asymmetries in monetary policy conduct in Ghana. To this effect, the results of the two methods employed will be discussed here.

5.3.1 The Autoregressive Distributed Lag Estimation results

This section presents the ARDL results for the baseline Taylor rule and augmented Taylor Rule.

The regression results using the ARDL are presented in Table 5.5, where the short-run and long-run coefficients are presented. The table also presents results on the Bounds Test and the speed of adjustment towards long-run equilibrium.

From the results in Table 5.5, it is observed from the baseline rule that the Central Bank smooths over changes in the monetary policy rate such that previous period increments in the policy rate led to a reduction in the policy rate by approximately 0.16%.

Again, in the short run, using the baseline Taylor rule, from May 2007 to December 2019, the monetary policy rate was responsive to inflation gap changes in the immediate past and two previous periods. Hence, if there was an increase in the inflation gap in the previous month, it led to an increase in the policy rate by 0.144%, and any increases in the inflation gap two periods (months) before led to the policy rate increasing by 0.276% approximately on average. This is in line with Bleaney et al.(2020), Akosah et al.(2020) and Caporale et al.(2018).

Table 5. 5 ARDL results for the Baseline Taylor rule and the Augmented Taylor Rule

Dependent Variable (MPR)			
Variable		Baseline Rule	Taylor Augmented Taylor Rule
Short Run	C	2007M5-2019M12	2007M5-2019M12
	D (MPR (-1))	0.318315***	6.207411***
	D (MPR (-2))	-0.16144**	-0.188461**
	D(INFLGAP)	0.083783	0.099007
	D (INFLGAP (-1))	0.144237*	0.090788
	D (INFLGAP (-2))	0.275936***	0.226633***
	D (INFLGAP (-3))		
	D(LREER)		-2.034095
	D (LREER (-1))		2.500678*
	D (LREER (-2))		2.742784**
	D (LREER (-3))		
Long Run	INFLGAP	1.428154**	0.890177***
	OUTPUT_GAP	31.62989	14.05993
	LREER		-14.66109***
	ECT	-0.0267**	-0.077387***
	Adjusted R-squared	0.983382	0.98455
	Bounds Test (F stat)	2.1121	4.318787*
	Observations	152	152
	Serial LM Test (Obs*R-squared) p-value	0.8159	0.9246
	ARCH Test (Obs*R-squared) p-value	0.9946	0.8862
	ARDL Lag Order	ARDL (2,3,0)	ARDL (2, 3, 0 ,3)

This table is the computation of the author using EViews 12. Note: ***, ** and * imply significance or rejection of null hypothesis at 1%, 5% and 10% respectively. The Serial LM Test is the Breusch Godfrey Serial LM Test, and the ARCH Test is the Autoregressive Conditional Heteroskedasticity Test. The Unrestricted Error Correction Model with no trend was used.

Again, using the baseline Taylor rule, in the short run, when inflation targeting was officially adopted, the output gap was not so much focused on in the short run as such monetary policy rate was not responsive to output gap changes since the official announcement in line with Bleaney et al.(2020) and Akosah et al.(2020)

A Bounds Test was conducted to observe the long-run relationship between the monetary policy rate, inflation gap, and output gap. This signals the Central Bank's conduct of monetary policy in the long run or its stance on monetary policy in the long run. The error correction term for the baseline Taylor rule was not interpreted since the Bounds Test is conclusive because there was no long-run relationship.

Now looking at the adjusted R^2 , in the sample period where inflation targeting was officially adopted, when the degrees of freedom are accounted for, the baseline Taylor rule explains 98.3382% of the variation of monetary policy rate around its mean.

An augmentation was made to the baseline model by introducing a new explanatory variable, the log of real effective exchange rates, as this would help study the effects changes in the real effective exchange rate had on monetary policy rate.

Considering the short-run effects, interest rate changes in the previous period affected the current interest rate. Hence, an increase in the policy rate in the previous rate led to a reduction in the current policy rate by 0.188%. This is in line with Bleaney et al.(2020), Akosah et al.(2020) and Caporale et al.(2018). This smoothing behaviour stabilizes the economy and does not lead to massive swings in the economy. The monetary policy rate responded to the inflation gap not in the current period but the previous two periods. Thus, if the inflation gap in the previous two periods increases by 1%, the monetary policy rate increases by 0.227%. This is in line with Bleaney et

al.(2020), Akosah et al.(2020) and Caporale et al.(2018) Since the official announcement of inflation targeting, the monetary policy rate using the linear specification of the Taylor rule does not respond to changes in the output gap. This is in line with Bleaney et al.(2020) and Akosah et al.(2020). Again, the real effective exchange rate affected the policy rate not in the current period but rather with lags of one period and two periods, respectively. A 1% increase in the real effective exchange rate in the previous period causes the monetary policy rate in the current period to increase by 0.025%. A 1% increase in the real effective exchange rate two periods ago led to an increase in the monetary policy rate by 0.0274%, in line with Akosah et al.(2020) and Caporale et al.(2018)

A bounds test was conducted on the long-run coefficients, looking at the long-run relationship. At 5% significance, it was found that there exists a long-run relationship for the augmented Taylor rule for the official announcement of the inflation targeting regime.

It is observed that the inflation gap and exchange rates influence monetary policy rates in the long run. Hence, an increase in the inflation gap by 1%, in the long run, leads to the monetary policy rate increasing by 0.8902%, which confirms the positive relationship between the inflation gap and the policy rate implied by theory and the expected inflation targeter in the long run. Hence though this result is in line with Bleaney et al.(2020), the coefficient should be greater than one to stabilize inflation since economic agents react to real values and not just nominal, and hence the increment in the policy rate must be greater than that of the increment in inflation gap. Bleaney et al.(2020) concluded that monetary policy was conducted to stabilise inflation, but the result in Table 5.5 does not share the same conclusion. The monetary policy rate is not responsive to the output gap in the long run though it is responsive to exchange rate changes in the long run. That is, a 1% increase in the real effective exchange rate leads to a reduction in the policy rate by

0.1466%, which is in line with the findings of Bleaney et al.(2020), Akosah et al.(2020), Caporale et al.(2018) and Akdoğan (2015).

The speed of adjustment towards long-run equilibrium was significant for the sample period. For official inflation targeting, 7.88% of the departures from the long-run equilibrium were corrected in the first period. Accounting for degrees of freedom, 98.3885% of the variability of the policy rate around its mean is explained by the estimated augmented Taylor rule over the entire sample. Again, accounting for degrees of freedom, 98.455% of the variability of the policy rate around its mean is explained by the estimated augmented Taylor rule when looking at the official inflation targeting period.

Looking at the p-values for the Breusch-Godfrey Serial Correlation LM Test and the ARCH tests, the augmented model is devoid of serial correlation and homoscedastic at a 5% significance level.

Observing the significance of the coefficient of real effective exchange rates gives an inclination that exchange rate is considered in the conduct of monetary policy, and hence an augmented monetary policy rate is more representative of monetary policy as compared to the traditional or baseline Taylor rule, conforming to Akosah et al.(2020), Caporale et al.(2018), Jawadi et al.(2014) and Taylor & Davradakis (2006). This is further highlighted by the forecast evaluation results to be presented later in this chapter that shows that the augmented rule in the official targeting period of 2007-2019 outperforms the traditional or baseline rule in predicting or forecasting monetary policy rate.

5.3.1.1 Residual Diagnostics

A serial correlation test using the Breusch-Godfrey Serial Correlation LM Test was conducted to investigate possible serial correlation. At a significance level of 5%, the null hypothesis of no serial

correlation cannot be rejected for the baseline model over the period where there was an official announcement of inflation targeting due to the p-values exceeding the significance level of 5%. An ARCH test was also conducted to test the hypothesis of constant variance in both models. At a 5% significance level, the null hypothesis of constant variance or homoscedasticity could not be rejected for the baseline model over the period where inflation targeting was officially admitted since the p-values exceeded the significance level of 5%. The Jarque-Bera test for normality also conducted on the residuals, showed that they were normally distributed.

5.3.2 Nonlinear Autoregressive Distributed Lag Estimation Results

This section presents results from the NARDL method which is employed in this study to investigate asymmetries in monetary policy conduct.

The research will now look at the results when asymmetry is considered as positive and negative deviations in the inflation gap, output gap, and real effective exchange rates.

Table 5.6 examines monetary policy conduct in the official inflation targeting period by investigating possible asymmetries. The table presents both short-run responses by the Central Bank as well as the long-run behaviour of the Central Bank in conducting monetary policy.

In the short run, the Central Bank smooths over changes in the policy rate. That is, they adjust the current policy rate while considering the policy rate in the previous period. Hence, if the policy rate in the previous period increases by 1%, the current policy rate will reduce by 0.2375%. This finding agrees with that of Bleaney et al. (2020), Akosah et al. (2020), and Bawumia et al. (2008).

In the short run, the monetary policy rate reacts to positive deviations in the inflation gap in the previous period. Hence if there was a 1% increase in the inflation gap in the previous period, the policy rate would increase by 0.2293% approximately on average.

Table 5. 6 Nonlinear Augmented Taylor Rule Results for 2007-2019

	DEPENDENT VARIABLE (MPR)	
	VARIABLE	Nonlinear Augmented Taylor Rule (2007-2019)
		COEFFICIENTS
Short Run	C	1.316733***
	D (MPR (-1))	-0.237533***
	D(INFLGAP_POS)	0.091849
	D (INFLGAP_POS (-1))	0.229271*
	D(INFLGAP_NEG)	0.026493
	D (INFLGAP_NEG (-1))	-0.001921
	D (INFLGAP_NEG (-2))	0.412121***
	D(OUTPUTGAP_POS)	3.642793*
	D(OUTPUTGAP_NEG)	-1.098811
	D (OUTPUTGAP_NEG (-1))	5.53746**
	D(LREER_POS)	-1.690914
	D (LREER_POS (-1))	4.931752***
	D (LREER_POS (-2))	4.634599***
Long Run	INFLGAP_POS	0.188898
	INFLGAP_NEG	1.208168***
	OUTPUTGAP_POS	0.658632
	OUTPUTGAP_NEG	-11.27702
	LREER_POS	-9.144381
	LREER_NEG	-13.23463
	ECT	-0.083123***
	Bounds Test (F-Statistic)	2.994215 (inconclusive)
	Adj. R squared	0.986033
	Serial LM Test (Obs *R-squared) p-value	0.435
	ARCH Test (Obs*R-squared) p-value	0.9722
	NARDL Lag Order	NARDL (2, 2, 3, 1, 2, 3, 0)

This table is the author's computation. Note: *, ** and * imply significance or rejection of null hypothesis at 1%, 5% and 10% respectively. Serial LM Test is the Breusch Godfrey**

Serial LM Test, and the ARCH Test is the Autoregressive Conditional Heteroskedasticity Test. The Unrestricted Error Correction Model with no trend was used.

In the case of negative deviations in the inflation gap, the monetary policy rate reacted to negative deviations in the inflation gap two periods ago. Hence, a 1% decrease in the inflation gap leads to an average 0.4121% decrease in the monetary policy rate.

The policy rate is found to react to positive and negative changes in the short run as these changes have been separated. A 1% increase in the current period output gap in the short run leads to an average of 0.0364% increase in the monetary policy rate. Now, if there was a 1% negative change in the output gap in the previous period, the output gap increases by 0.0554% approximately.

Again, in the short run, the monetary policy rate reacts to positive deviations in the real effective exchange rate in the previous period and two periods ago but does not show any short-run reactions to negative deviations in the real effective exchange rate. Thus, in the previous period, a 1% increase in the real effective exchange rate in the previous period leads to a 0.04932 percentage point increase in the monetary policy rate on average. Again, a 1% increase in real effective exchange rate two periods prior leads to the policy rate in the current period increasing by 0.0463 percentage points.

The Bounds Test conducted for cointegration or long-run relationship was inconclusive. Bannerjee et al. (1998) concluded that to establish a long-run relationship in autoregressive distributed lag models, it suffices to test the significance of the lagged dependent variable, the error correction term's coefficient. Again, looking at the works of Kremers et al.(1992), Bahmani-Oskooee & Nasir (2004), and Iwata et al. (2012) who suggested that an efficient way of establishing long-run relationships is by examining the significance of the coefficient of the error correction term. In this

case, the coefficient of the error correction term is significant at 1%, and as such, we can conclude the presence of a long-run relationship.

In the long run, we observe that the monetary policy rate reacts to negative deviations in the inflation gap and negative deviations in the real effective exchange rate. In the long run, a reduction in the inflation gap by a percentage point leads to the monetary policy reducing by 1.21%, approximately

Looking at the error correction term coefficient, it is observed that 8.31% of deviations from long-run equilibrium are corrected in the first period. Accounting for degrees of freedom, the model in Table 5.6 explains approximately 98.6% of the variation of the monetary policy rate.

5.3.2.1 Test of Asymmetry

In this section, test for asymmetry both in the short-run coefficients and in the long-run coefficients. This test is a coefficient restriction test and is therefore performed using the Wald Test for restriction.

Table 5. 7 Wald Test for Short Run Asymmetry in coefficients

H₀: Short Run Symmetry			
H₁: Short Run Asymmetry			
Inflation Gap	F-statistic	0.170082	p-value 0.6807
Output Gap	F-statistic	0.037868	p-value 0.8460
Real Effective Exchange Rate	F-statistic	6.769867	p-value 0.0104

Source: Author's Computation

From Table 5.7 above, there is symmetry in the short-run reactions to inflation and output gaps, but the Central Bank reacts asymmetrically to real effective exchange rates at a 5% significance level in the short run. This gives evidence of asymmetric behaviour by the Central Bank.

The research now will test the existence of asymmetries in monetary policy conduct in the long run. Again, the study uses the Wald Test for restriction.

Table 5. 8 Wald Test for Short Run Asymmetry in coefficients

H₀: Long Run Symmetry				
H₁: Long Run Asymmetry				
Inflation Gap	F-statistic	3.49248	p-value	0.0639
Output Gap	F-statistic	0.0639	p-value	0.1603
Real Effective Exchange Rate	F-statistic	0.49637	p-value	0.4824

Source: Author's Computation

Table 5.8 shows an asymmetric response to the inflation gap at a 10% significance level in the long run. This is because the negative deviations' long-run coefficient was significant compared to the positive deviations in the inflation gap. This could be a case of an aversion on the part of the Central Bank to an economic downturn, and hence it is easier to reduce the policy rate when there are negative deviations in the inflation gap since this leads to an increase in output or economic activity. For the other variables, though, there was long-run symmetry as the study could not reject the null hypothesis of long-run symmetry. This result is in line with Akosah et al.(2020), Caporale et al. (2018) and Akdoğan (2015), who also found asymmetry in response to inflation gap deviations using threshold regression.

5.3.2.2 Residual Diagnostics

The study now observes and conducts tests on the residuals of the NARDL model above. Table 5.6 shows that the Breusch-Pagan Serial Correlation LM and the Autoregressive Conditional Heteroskedasticity tests show no serial correlation and heteroskedasticity, as the null hypothesis for both tests could not be rejected, respectively. The Jarque-Bera Histogram Test for normality (Figure can be found in the appendix) concluded that the residuals are normally distributed.

5.4 Model Comparison and Forecast Evaluation

In this section, the study seeks to compare the estimated Taylor rules and judge the best sample fit among all three models. Initially, the adjusted R squared will be used to compare and afterwards forecast evaluation statistics such as Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), Symmetric Mean Absolute Percentage Error (SMAPE), and both Theil's Coefficients will also be used to judge the best sample fit amongst all three models.

First, looking at the adjusted R squared ranks, the linear baseline Taylor rule had an adjusted R squared of 0.983382. The augmented linear rule had an adjusted R squared of 0.98455. The nonlinear augmented rule had an adjusted R squared of 0.986033. Thus, in terms of the coefficient of determination, the nonlinear augmented rule outperformed the other two rules in explaining the variability of the policy rate around its mean. Again, comparing the two linear rules, the augmented linear rule outperformed the linear baseline rule in explaining the Central Bank's policy actions.

The study uses forecast evaluation tools for all three models to observe which rules could forecast better in-sample and hence describe monetary policy actions well.

Table 5. 9 Forecast Evaluation Statistics Table

Evaluation statistics						
Forecast	RMSE	MAE	MAPE	SMAPE	Theil U1	Theil U2
MPRFBASELINE	2.058795	1.597653	8.835765	8.653344	0.056797	3.412083
MPRFAUGMENTED	1.123188	0.925479	5.187641	5.190574	0.030967	1.884668
MPRFNARDL	0.813494	0.625616	3.579808	3.591282	0.022327	1.399778

Source: Author's computation

Table 5.9 displays the forecast evaluation statistics. Using these evaluation statistics, there was less error in the nonlinear augmented rule predicting the policy rate path compared to the linear models. This signals that there is a case for nonlinear monetary policy rules in Ghana; that is, monetary policy conduct displays asymmetric preferences. Furthermore, the augmented rule also made fewer errors in forecasting the monetary policy rate than the baseline linear Taylor rule. This shows that exchange rate changes factor into monetary policy decisions and must be included in the policy rule. The forecast graph is included below.

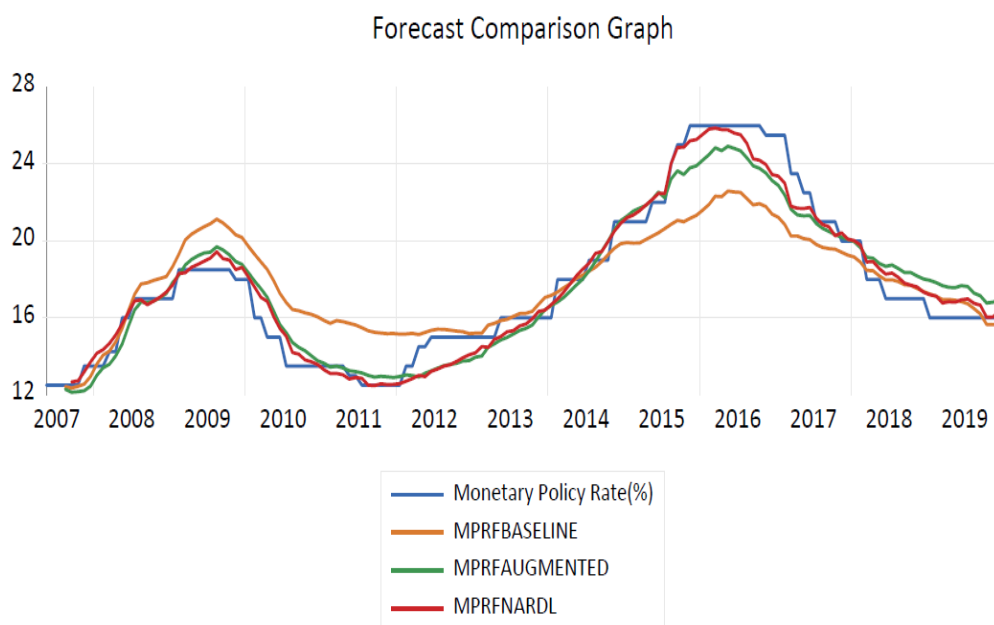


Figure 5. 1 Forecast Comparison Graph of the estimated models

The forecast comparison graph below shows that the nonlinear augmented rule better predicts the movements and dynamics in the monetary policy rate than the linear ones. This further shows that in the monetary policy conduct in Ghana, nonlinear rules give a better description and thus signifying the presence of asymmetric preferences. It is also observed that the augmented linear

rule does a better job predicting the path of monetary policy rate than the baseline linear case. This further buttresses the evidence that the exchange rate is considered in monetary policy conduct and should be included in policy rules like the Taylor rule since it offers excellent insights into policy conduct.

5.5 Stability Diagnostics

The stability of all three models is tested in this study. The Cumulative Sum (CUSUM) and the Cumulative Sum Squared (CUSUMSQ) tests are used to test model stability. The tests conclude that all three models are stable over time as the recursive residuals are all within the significance level band. The figures for these tests can be found in the appendix.

5.6 Conclusion

This chapter discusses the results of the various statistical methods employed in this study. Descriptive statistics were used to describe the variables over the sample period, where metrics like the mean, median, standard deviation, and skewness were discussed. The measure of association also looked at the relationships between variables. The Augmented Dickey-Fuller and Phillips Perron tests were used to test the presence of unit roots. It was found that the output gap was stationary at levels while the monetary policy rate, inflation gap, and the real effective exchange rate are stationary at first.

The estimates from the econometric methods employed were displayed and discussed in detail. It was observed that the policy rate decisions react to changes in the real effective exchange rate, and it was shown that the augmented rule outperformed the linear baseline rule whilst forecasting in-sample, and it explained more variability in the monetary policy rate around its mean. The nonlinear rule estimates were also discussed in detail in this chapter. The results showed that there was a short-run asymmetric response to exchange rates. The long-run estimates also showed a

long-run asymmetric response to the inflation gap where the Central Bank reacted aggressively in reducing the policy rate in periods where the inflation gap reduced but did not react so aggressively in increasing the policy rate to slow down the inflation gap increase. It was also shown that the nonlinear augmented rule outperformed the linear rules in describing the path of the monetary policy rate. Hence, the study concludes that the nonlinear augmented rule best describes monetary policy conduct in Ghana.

This chapter also looked at various model diagnostics to confirm that the model is a good fit and devoid any problems like serial correlation, heteroskedasticity and nonstationarity. It was found that there was no evidence of serial correlation and heteroskedasticity. The estimated models were stable, and the residuals were normally distributed.



CHAPTER SIX

SUMMARY, CONCLUSIONS, AND POLICY RECOMMENDATIONS

6.0 Introduction

This chapter presents a summary of the entire study. It looks at the main reasons for conducting this study and the findings of the study. The chapter briefly discusses the results obtained using the ARDL and NARDL techniques. The implications of these findings are stated in this chapter. The limitations of this study are presented in this chapter.

6.1 Summary and Conclusion of the study

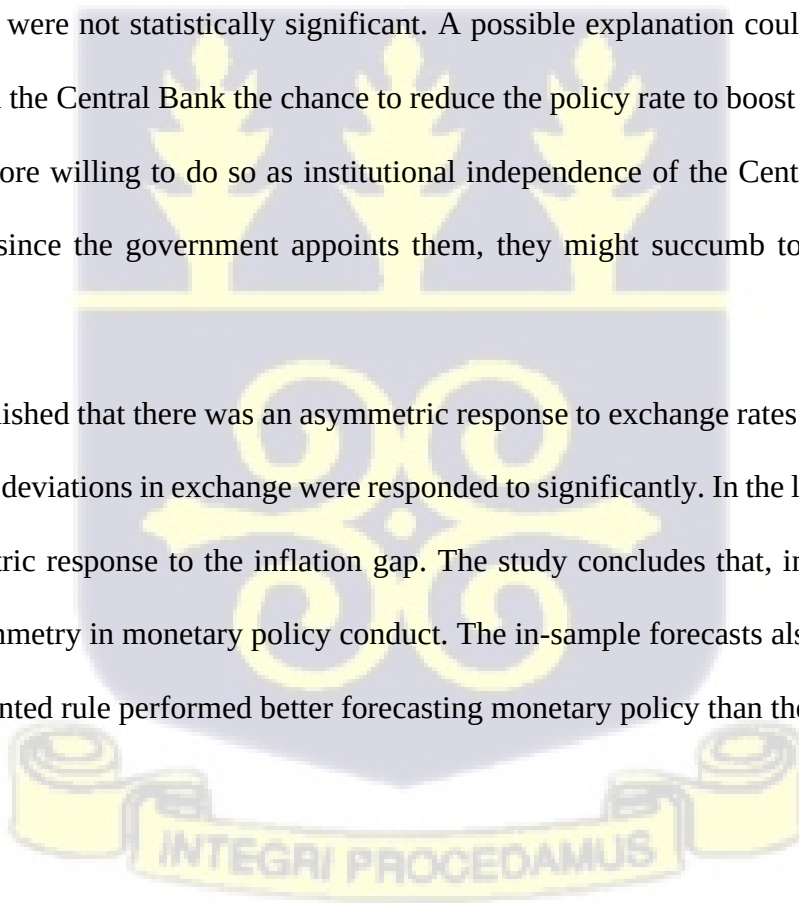
This study aimed to explore whether exchange rates are considered in the conduct of monetary policy with the Taylor rule framework. The study also aimed to investigate the presence of asymmetric preferences on the part of the Central Bank by reacting asymmetrically to the positive and negative deviations in the variables in the Taylor rule.

The results from the linear augmented rule showed that the exchange rate indeed was a factor in determining the monetary policy rate hence furthering the argument in favour of including the exchange rate in the Taylor rule to account for external influences on inflation since there is a high exchange rate pass-through to inflation in Ghana. It was also shown that the linear rule containing the exchange rate outperformed the baseline Taylor rule, again buttressing the result that the exchange rate is a key variable in the interest rate setting behaviour of the Central Bank. It was also found that the Central Bank smooths over changes in the policy rate which conforms to the existing literature on monetary policy conduct in Ghana (Akosah et al., 2020; Bawumia et al., 2008; Bleaney et al., 2020).

Now looking at partial decompositions in the variables in the Taylor rule to observe positive and negative deviations and how the Central Bank reacts, it was found that for the inflation gap, the Central Bank reacted to positive deviations in the previous period in the short run as well as negative deviations two periods before. There were significant reactions to positive output gap deviations in the current period in the short run and negative deviations in the output gap in the previous period. The policy rate in the short run also responded to positive deviations in real effective exchange rates from the previous period and two previous periods. There was no response to negative deviations in the exchange rate in the short run.

In the long run, however, the Central Bank only reacted to negative deviations in the inflation gap significantly. Hence, though the other variables had signs that conformed to the Taylor rule framework, they were not statistically significant. A possible explanation could be that negative deviations afford the Central Bank the chance to reduce the policy rate to boost economic activity and hence are more willing to do so as institutional independence of the Central Bank is not so strong and that since the government appoints them, they might succumb to the governments wants.

It was also established that there was an asymmetric response to exchange rates in the short run as only the positive deviations in exchange were responded to significantly. In the long run, there was also an asymmetric response to the inflation gap. The study concludes that, indeed, there is the presence of asymmetry in monetary policy conduct. The in-sample forecasts also showed that the nonlinear augmented rule performed better forecasting monetary policy than the linear models.



6.2 Implication and Policy Recommendations

This study offered some insight into monetary policy conduct and observed whether there was conformance to the traditional work of Taylor (1993). It is found that nonlinear rules represent monetary policy conduct in Ghana by looking at short-run and long-run reactions to the monetary policy rate.

The following recommendations can be made from the findings of the study:

Firstly, the exchange rates are to be included in the discussion of appropriate monetary policy rules, especially in small open economies that are prone to external shocks and are mostly import-dependent, as well as in the case of Ghana. As Loloh (2014) asserted, there is a high exchange rate pass-through to inflation in Ghana; hence, to achieve price stability, the Central Bank must pay attention to changes in the exchange rate. This thus helps make a case for the inclusion of the exchange rate in the monetary policy rule, as Akosah et al. (2020) asserted.

Secondly, there are nonlinearities in monetary policy conduct in Ghana. There are asymmetric responses to the inflation gap and exchange rate. Hence the assumption of symmetry in responses using a symmetric loss function specification by Taylor (1993) is not representative in the Ghanaian case. In the Ghanaian case, it is observed that the Central Bank reacts aggressively to negative deviations in the inflation gap in the long run but not so aggressively to positive deviations. This does not help with policy credibility as economic agents will not always believe price stability is the central bank's primary aim; hence, it will be quite difficult for the Central Bank to achieve the set inflation target. To achieve and maintain the target inflation, the Central Bank must try as much as possible to react aggressively to positive deviations as it reacts to negative deviations. This helps improve credibility as economic agents would always trust that price stability is always the goal.

Thirdly, the independence of the Central Bank is essential to its ability to perform its critical role in economic growth. The government appoints most officials. This thus makes them accountable to the government to some extent, hindering the Central Bank in its monetary policy conduct. This is because there may be periods when the government may want the Central Bank to undertake expansionary policies, leading to inflationary pressures. Since most of the officials in the Bank of Ghana are appointed by the government, it may be difficult to go against the government's wishes. There must be adequate measures put in place to ensure the independence of the Central Banks. One such measure is to separate the Central Bank from the government entirely and grant full independence to the Central Bank to conduct monetary policy. Doing so will help the Central Bank pursue its main objective, price stability without hindrances.

6.3 Limitations of the Study

A limitation to this study is that it takes a more contemporary look at monetary policy and hence loses some valuable insights brought by the forward-looking models, as in inflation targeting, the Central Bank forecasts the next period of inflation. It addresses any discrepancy in the forecast and the target levels. This may present a delayed policy decision to upcoming shocks.

Again, due to the inflation targeting regime being officially adopted in May 2007, the data available is not expansive enough to offer much more insight. Data availability was also an issue as variables like output were not recorded monthly and had to be proxied. An expansive dataset gives room for robust estimations and much more information.



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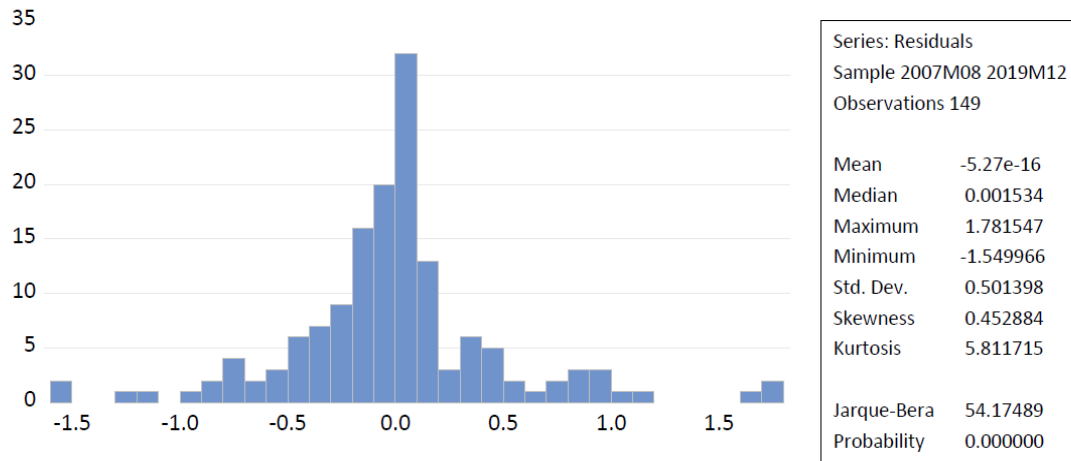
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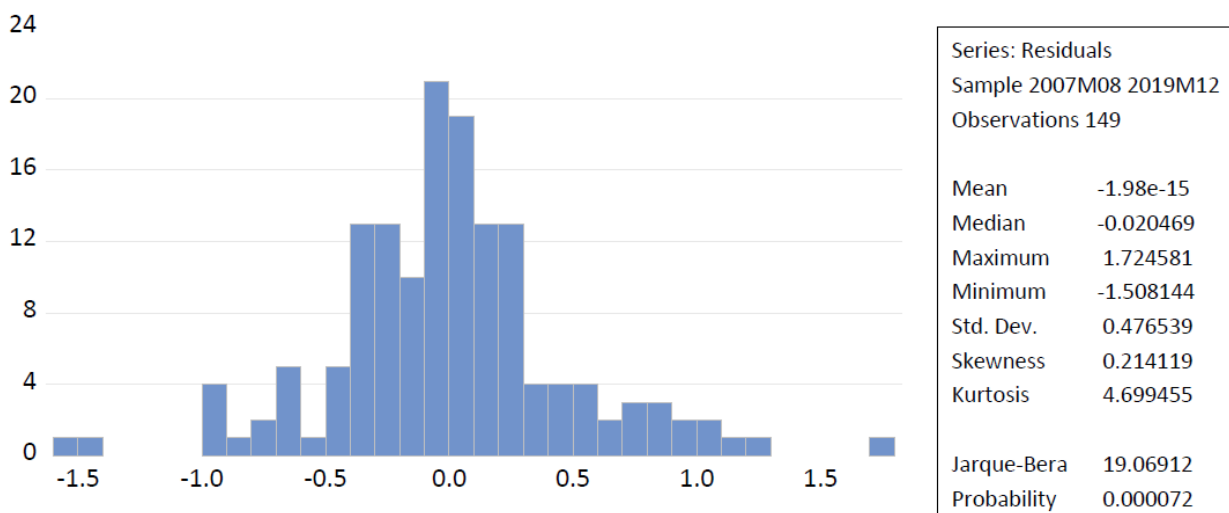


APPENDIX

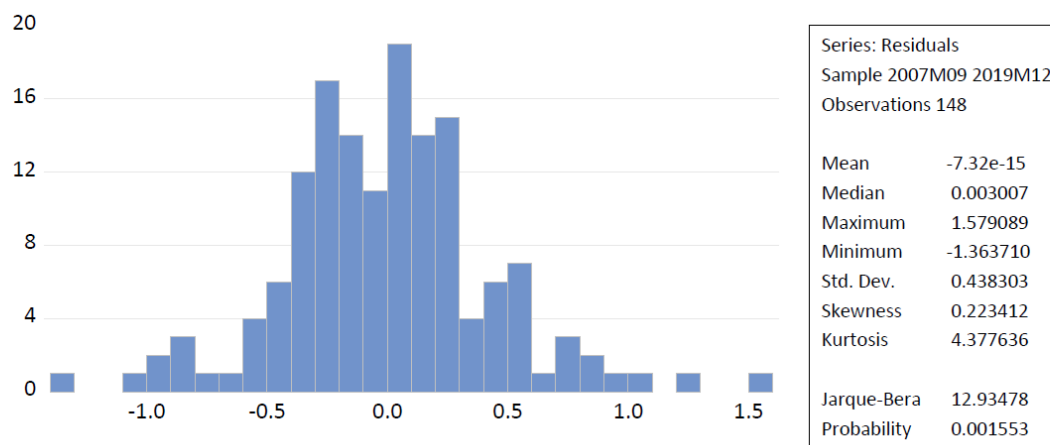
Appendix 1: Jarque-Berra Histogram Normality Test for Baseline Taylor rule



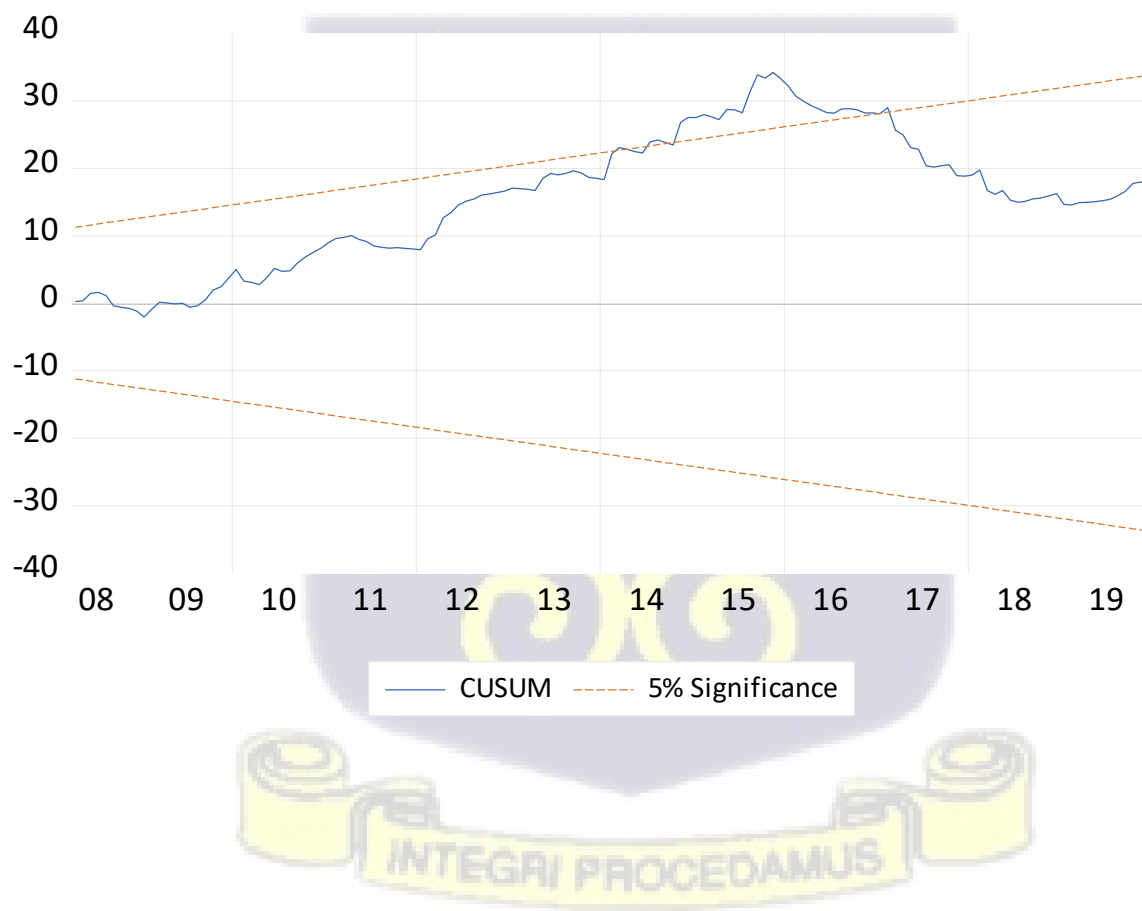
Appendix 2: Jarque-Berra Histogram Test for normality for linear augmented Rule

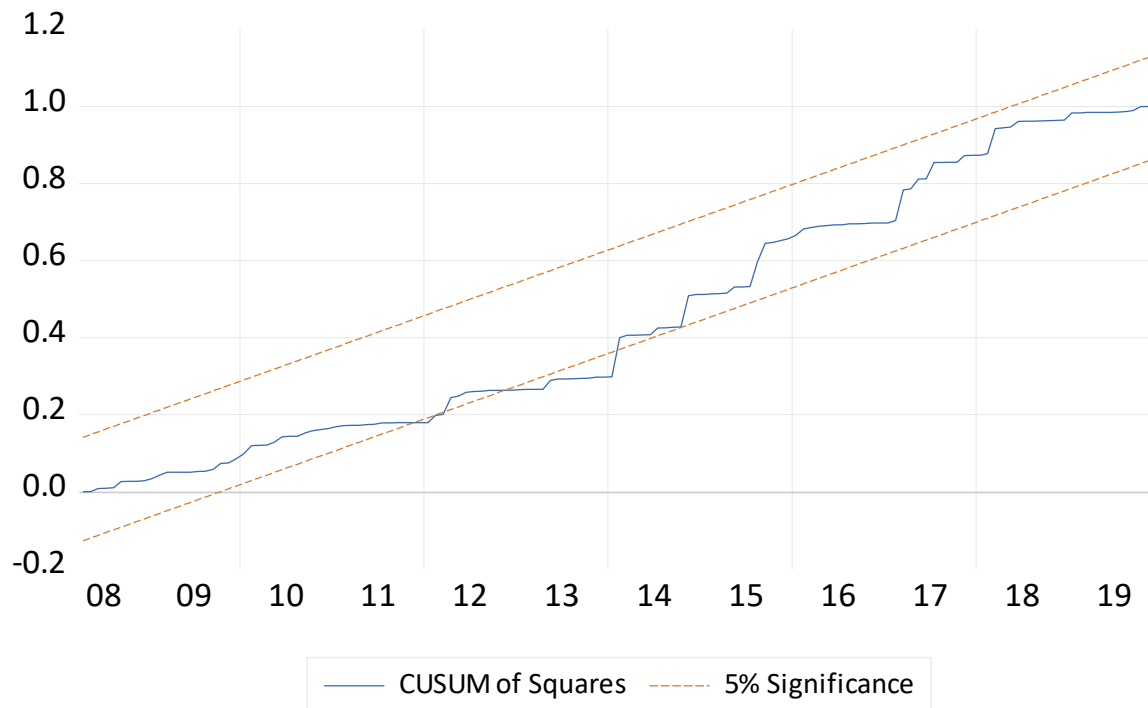


Appendix 3: Jarque-Berra Histogram Test for normality for nonlinear augmented Rule

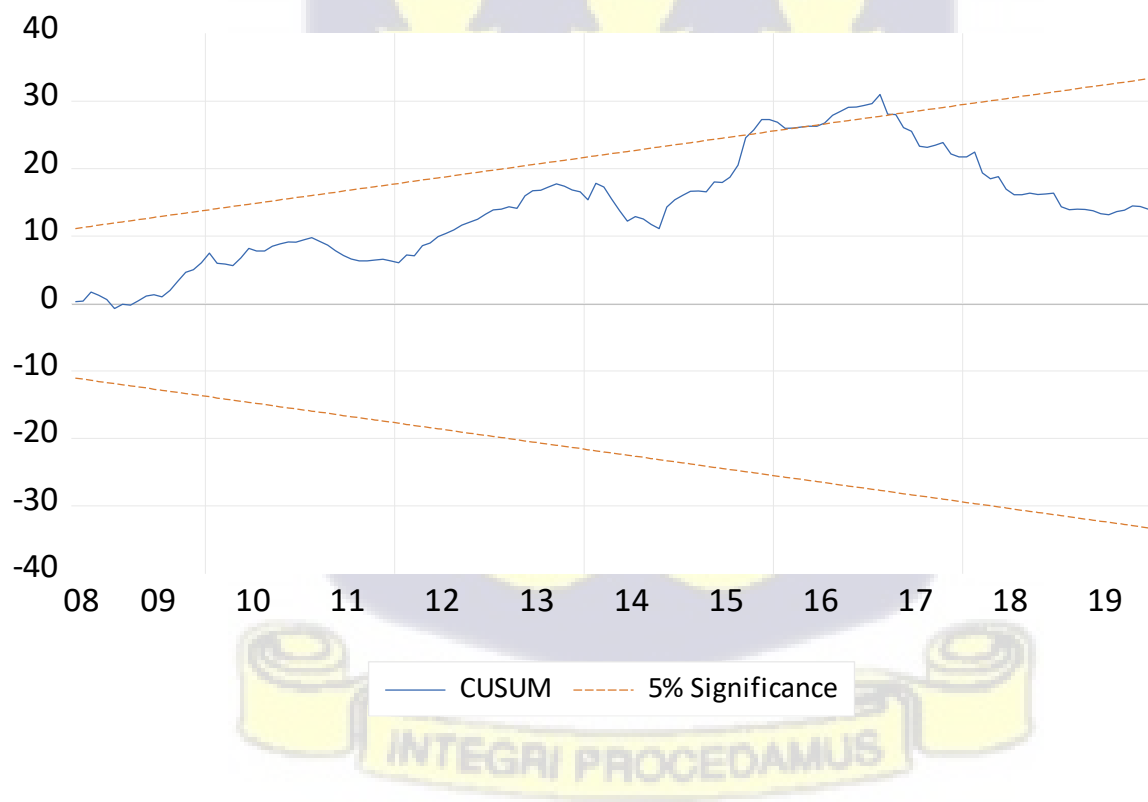


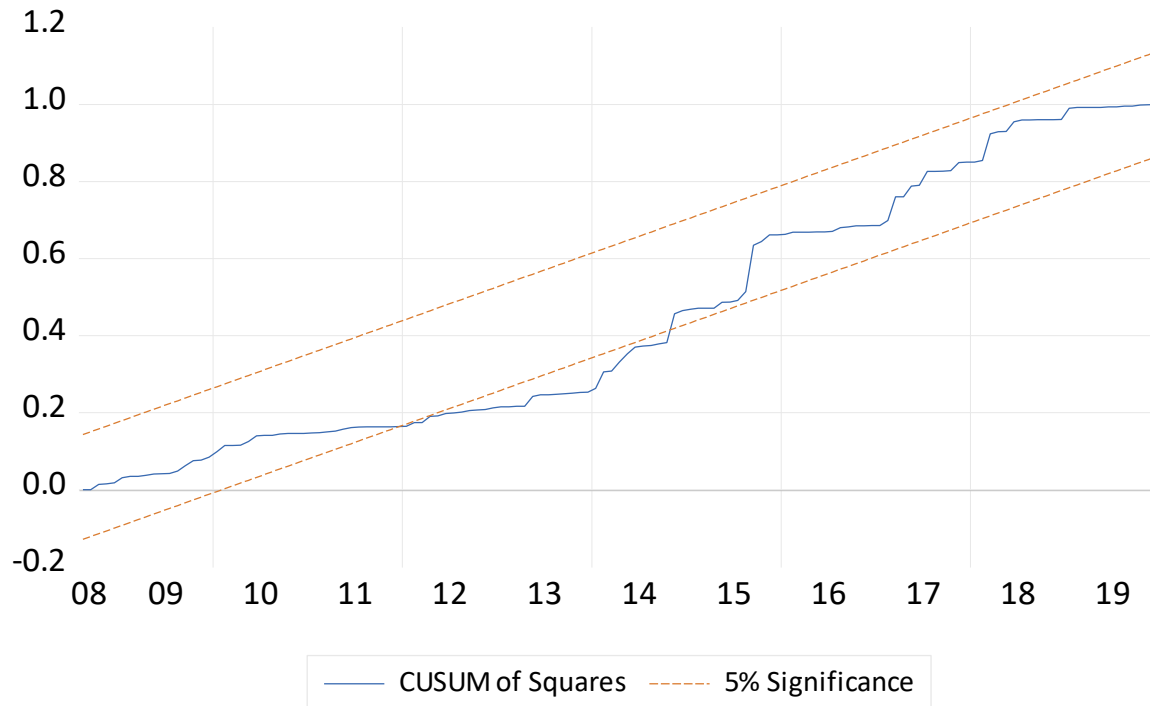
Appendix 4: CUSUM AND CUSUMSQ Test Diagrams for Baseline Taylor Rule



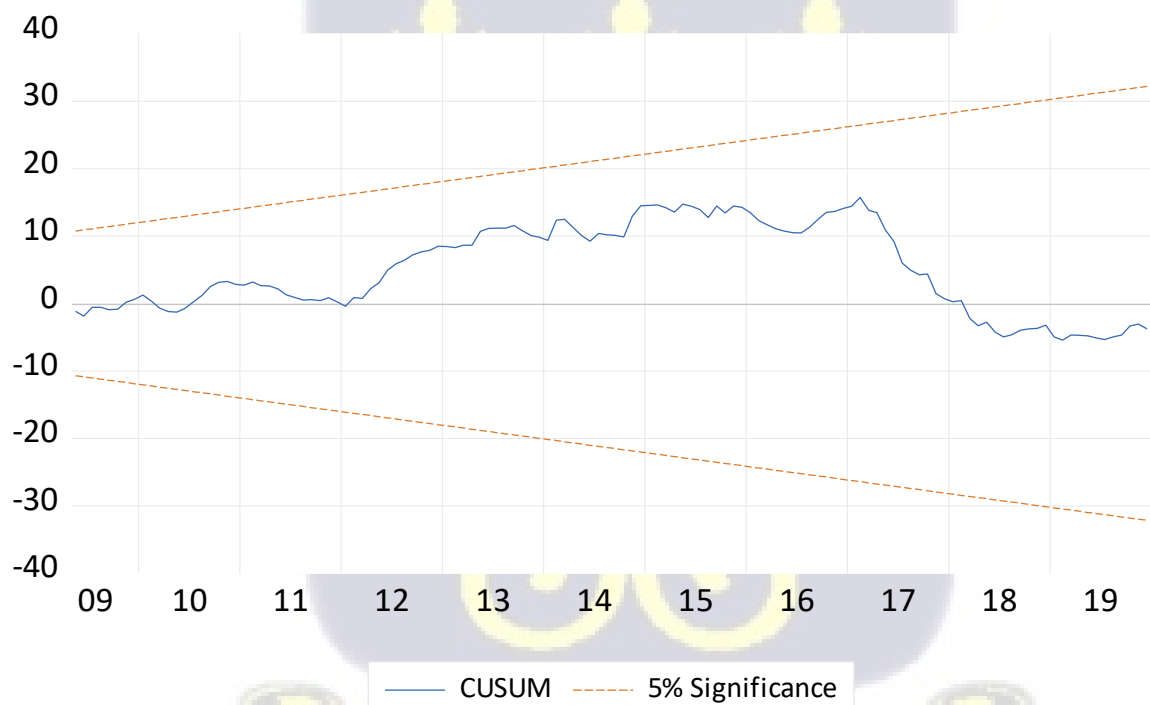


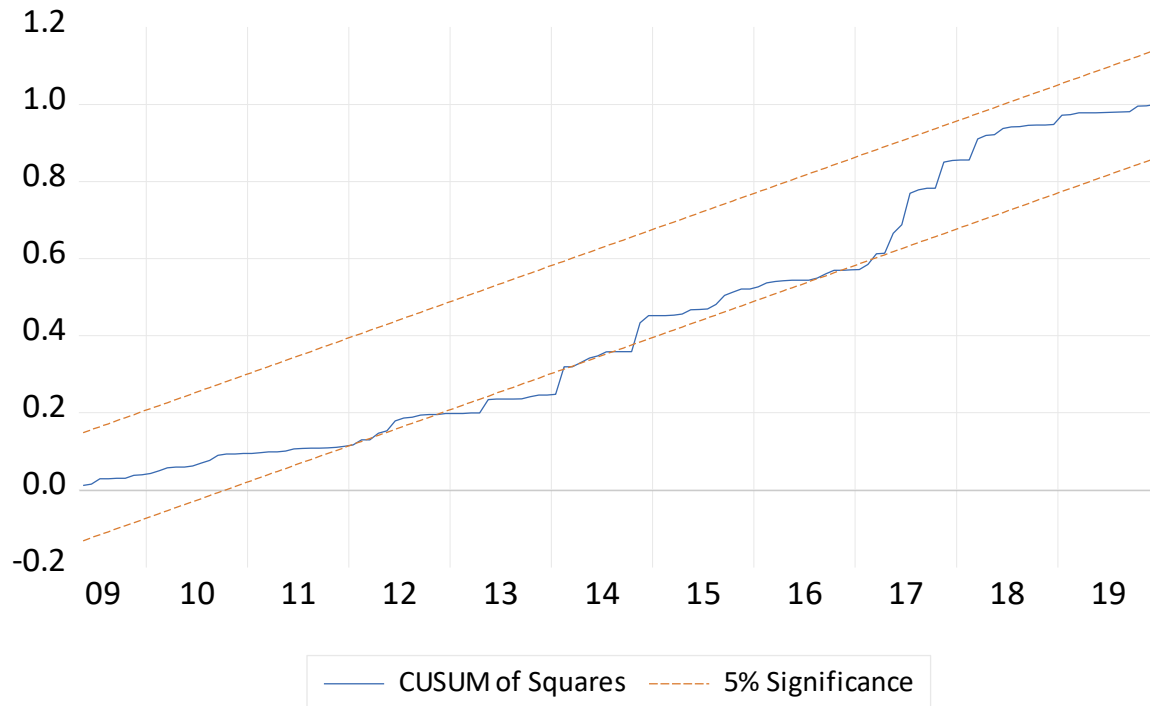
Appendix 5: CUSUM AND CUSUMSQ Test Diagrams for Augmented Taylor Rule





Appendix 6: CUSUM and CUSUMSQ Test for Nonlinear Augmented Taylor rule





Appendix 8: Dynamic Multiplier Graphs depicting short-run asymmetry in exchange rates and long-run asymmetry in inflation gap

