

**INFLATION TARGETING AND EXCHANGE RATE PASS-THROUGH: AN
EMPIRICAL INVESTIGATION IN GHANA.**

BY

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DECLARATION

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

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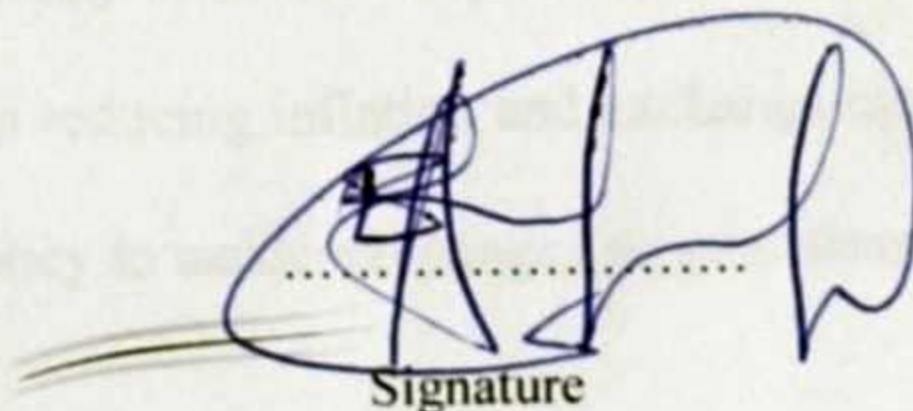

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ABSTRACT

One major economic challenge facing small open developing economies such as Ghana is the issue of an effective and credible monetary policy to sustain the value of their domestic currency and mitigate the effects of exchange rate on the domestic economy. Ghana adopted the inflation targeting (IT) framework since 2002 and this has unarguably ensured a reduction in inflation but its effect on the nature of exchange rate pass-through has not been extensively discussed. The study therefore sought to investigate the effect of IT on inflation and exchange rate passes through in Ghana. Using quarterly data from 1995Q1 to 2011Q4, the ARDL approach was used to establish the long run and short run effects of exchange rate on inflation. A dummy variable capturing the periods before and after the adoption of IT was introduced along with an interaction term between the dummy variable and the exchange rate to assess the effect of IT on inflation and exchange rate pass-through in Ghana. The stationarity of variables were investigated with the Augmented Dickey-Fuller and Phillips-Perron unit root test to ensure no variable is integrated to order two ($I(2)$) or more. The results of the study showed that money supply and exchange rate are the major contributors to inflation in Ghana in the long run. Exchange rate depreciation was the only significant contributor to inflation in the short run. The introduction of the IT policy significantly led to a reduction in average inflation both in the long run and short run. More importantly, the pass-through from exchange rate to inflation was found to have reduced drastically after the adoption of the IT framework. This suggests that IT has been very successful in reducing inflation and exchange rate pass-through drastically. Therefore IT is an appropriate policy to tackle exchange rate pass-through and inflation in Ghana.

DEDICATION

This study is dedicated to my mother, Mrs Grace Bonsra and guardians

Mr Henry Ani-Boi, Mr George Tetteh and Mrs Suzy Yeboah

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I am wholeheartedly grateful to the Almighty God who graciously granted me His protection and guidance to undertake this program to a successful completion. I express my sincere gratitude to my mother, Mrs Grace Bonsra and Siblings Enoch Manu, Mrs Jenifer Tettey, Mrs Dorcas Intsiful and Richmond Manu.

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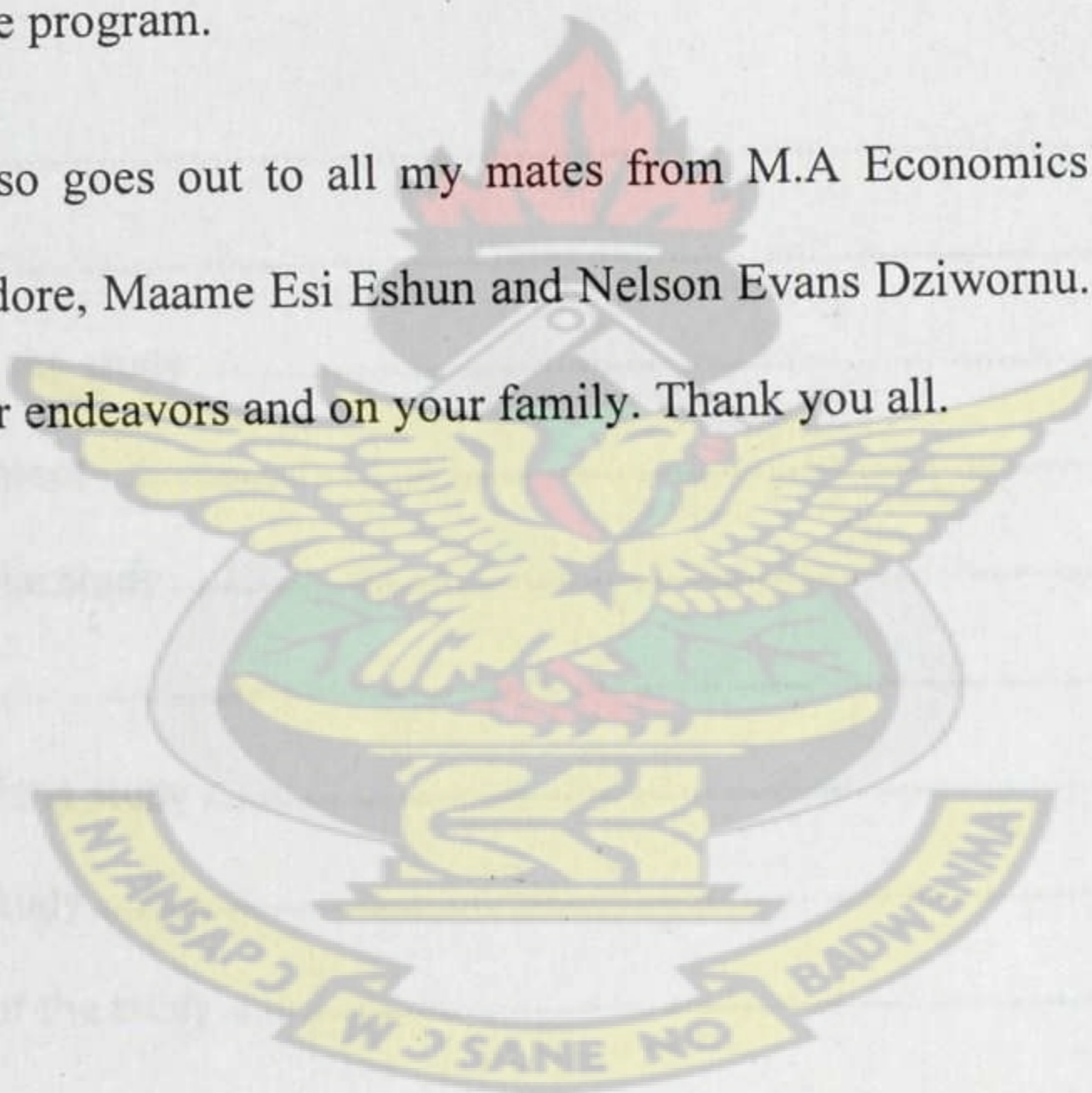


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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

One major economic challenge facing small open developing economies such as Ghana is the issue of an effective and credible monetary policy to sustain the value of the domestic currency and mitigate the effects of exchange rate on the domestic economy. Following the 1990 exchange rate crises, many emerging economies have opted to change the focus of their monetary policy from exchange rate targeting to inflation targeting as a means of ensuring macroeconomic stability (see Reginaldo, 2007). This has become even more eminent today considering the rate at which countries are going into agreements for free trade with their trading counterparts.

Ghana as one of such countries opted to switch from money-growth targeting to inflation targeting (IT) framework in 2002. Bank of Ghana's data on inflation for Ghana shows a significant decline in the average inflation after the adoption of IT framework. The annual average inflation measured by percentage change in the consumer price index has declined from an average of 32% from 1995Q1 to 2001Q4 to an average of 15.74% from 2002Q1 to 2011Q4. This has led to works such as Kyereboah-Coleman (2012) concluding that IT has had a significant impact on the reduction of inflation in recent years and has reduced the persistence of inflation series considerably in Ghana.

A significant contributor to inflation as established by Sowa and Kwakye (1993), Bamumia and Abradu-Atooo (2003), and Sanusi (2010) is exchange rate depreciation. Recent literature has also shown that the impact of exchange rate on domestic inflation, today called exchange rate pass-

through (ERPT), has been declining for emerging countries (eg Mexico, South Africa and Brazil) that adopted inflation targeting framework but that of Ghana has not been well established in the literature. (see Reginaldo, 2007). Following Pesaran et al (2001) as summarised in Frimpong and Oteng-Abayie (2006), Sakyi (2011), Frimpong and Adam (2010) and Adu and Marbour (2011) the purchasing power parity relationship is used with the help of an Autoregressive Distributed Lag (ARDL) model to establish the magnitude and nature of the relationship between exchange rate and domestic inflation for the periods before and after the adoption of inflation targeting (IT) framework by the Bank of Ghana (BoG).

Exchange rate pass-through as defined by Goldberg and Knetter (1997) is “the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries”. The extent to which exchange rate fluctuations are pass-through to domestic prices has recently assumed a centre stage in international finance with many debates still on-going. As shown in many theoretical and empirical research, the degree of exchange rate pass-through matters a lot due to its stark implications for the conduct of monetary policy (see Smets and Wouters, 2002; Adolfson, 2002; Sutherland, 2002; and Corsetti and Pesenti, 2005), influence on the choice of exchange rate regime (see Engel (2002); Devereux and Engel, 2003), and the role it plays in International transmission of shocks (see for example Betts and Devereux, 2001). Exchange rate pass-through (ERPT) in the literature has been found to be more of a problem in emerging economies than the developed economies. Some empirical works, such as Calvo and Reinhart (2002), Goldfajn and Werlang (2000) and Schmidt-Hebbel and Tapia (2002), have shown that ERPT is higher in emerging economies than in developed economies. The pass-through from exchange rate to domestic inflation has been found to be positive and significant but incomplete in most emerging economies. This is evident in the works

of Mihaljek and Klau (2001) and Ca' Zorzi et al (2007). The situation in Sub-Sahara Africa has been found not to be any different from that pertaining in other emerging economies. Canetti and Greene (1992) in their work in sub-Saharan Africa found that exchange rates have a significant “Granger causal” relationship with prices in Tanzania, Sierra Leone, and the Democratic Republic of Congo.

In Ghana, the issue of exchange rate affecting domestic inflation has recently taken a center stage in our economic and political discourse. Ghana over the years has not been spared from the detrimental effect of exchange rate depreciation on its domestic inflation due to its status as an importing economy. The link between exchange rate and domestic inflation in Ghana as empirically established in the work of Bamumia and Abradu-Atooo (2003) has proven to be positive. Frimpong and Adam (2010) found a low and insignificant exchange rate pass-through in the long run and attributed this to the increased openness of the economy. Sanusi (2010) in his work also found that the pass-through to consumer prices in Ghana, although incomplete, is substantially large and therefore concludes that exchange rate depreciation is a potentially important source of inflation in Ghana.

In the face of high and volatile inflation in the 1970s and the first part of the 1980s in most Organization for Economic Cooperation and Development (OECD) countries, New Zealand embarked on tight monetary policy which saw inflation falling in the latter part of 1980s. As part of a more far-reaching reform of the central government administration in New Zealand, a new Reserve Bank Act was established. The Reserve Bank Act of 1989 established the policy framework we call inflation targeting today. Bernanke et al (1999) defines inflation targeting as: “a framework for monetary policy characterized by the public announcement of official quantitative targets for the inflation rate over one or more time horizons and by explicit

acknowledgment that low, stable inflation is monetary policy's primary long-run goal". The framework had three key aspects, (i) an inflation target for monetary policy, (ii) central bank independence, and (iii) accountability of the central bank. Inflation targeting since then has seen a quick spread to many developed and developing countries with UK, Sweden, Finland, Australia, South Africa, Ghana .etc. all joining the league of countries operating an explicit inflation targeting framework.

In the case of Ghana, the introduction of the 2002 Bank of Ghana's act (Act 612) with an explicit primary objective of price stability and promoting growth as its secondary objective gave the BoG independence with respect to the selection of tools leading to their adoption of the IT framework as their main tool of operation. The BoG Act 612, section 33(2) states, "The Bank, in counteracting unusual movements in the money supply and prices in the country shall, after consultation with the Minister, use any of the instruments of control conferred upon it under this Act or under any other enactment to maintain and promote a balanced growth of the national economy". This gave them the operational and political freedom to set their own policy interest rate with the prime aim of stabilizing prices in the economy. Ghana informally started practicing inflation targeting in 2002 but the official announcement to the commitment of a full fledge inflation targeting framework was made in May, 2007, thus a step towards making the BoG to be held accountable for its mandate of delivering price stability as stated in the 2002 BoG Act.

For a country to be classified as a Full Fledge Inflation Targeting (FFIT) there must be some conditions to show its level of commitment. This according to Stone (2003) includes total transparency in the operations of the central bank, a single anchor monetary regime (thus IT), a well structured and developed financial system, announcement of inflation target at the beginning of each year and the practice of a free floating exchange rate system. One can say

without a shred of doubt that the conditions that pertained in the Ghanaian economy from 2002 to 2011 were neither that of a free floating exchange rate regime, a well-developed financial sector nor a single anchor monetary regime. In the face of the recent depreciation of the cedi and the interventions by the central bank in 2008, one can question the BoG's full commitment to the IT framework as announced in 2007 since a free floating exchange rate regime is a requirement for the monetary authorities of a country to gain full credibility as one of a FFIT policy adopter. Opoku-Afriyie (2005) in making reference to Stone (2003) and Porter and Yao (2005) classified the monetary policy of Ghana as one of an *inflation targeting lite* (ITL). Stone (2003) and Porter et al (2005) gave the characteristics of an ITL regime as:

- multiple monetary policy objectives.
- mixed operating targets and instruments including short-term interest rates, exchange rate, reserve money or aggregate money supply.
- exchange rate intervention
- constrained transparency of monetary policy operations
- financial stability

One can therefore observe that even though Ghana is gradually moving towards a single monetary policy objective with a single operational target and has also announced its commitment to the IT framework, it cannot be said that Ghana is currently practicing a FFIT framework with total transparency.

Recent literature has shown that the pass-through from exchange rate to domestic inflation in most emerging economies has been reducing. Works like Mishkin and Savastano (2001), Schmidt-Hebbel and Werner (2002), Taylor (2000), BIS (2002), Choudhri and Hakura (2001),

Garcia and Restrepo (2001), and Campa and Goldberg (2002) using different empirical methods generally attribute the reduction in the pass-through to various factors such as credibility of the monetary policy regime, the inflation environment, output gaps, and the industry composition of a country's import bundle. Other works such as Reyes (2004), Reginaldo (2007) and Civeir and Akçağlayan (2010) rather attribute the recent decline in the pass-through from exchange rate to domestic inflation to the adoption of an inflation targeting policy.

Ghana, since the adoption of the inflation targeting policy framework in 2002 has been experiencing a steady decline in inflation with very few fluctuations. Most literature on Ghana has attributed this decline to the tight fiscal and monetary policies pursued by successive governments and monetary authorities in Ghana. The empirical role played by exchange rate pass-through to this declining inflationary environment in the face of inflation targeting seems to be lacking in the literature. This work therefore seeks to investigate whether there has been any significant change in the magnitude and nature of the pass-through from exchange rate to domestic inflation after the adoption of the inflation targeting framework by the monetary authorities of Ghana in 2002.

1.2 Problem statement

In the face of the great depression coupled with the failure of the classical theory of free market with no interference to solve the increasing problem of unemployment, the Keynesian view of an increase in government spending and manipulation of interest rate in order to increase aggregate demand became the dominant paradigm after the Great Depression. This according to Bawumia and Abradu-Otoo (2003) ushered in an era of direct controls as the monetary policy framework of most countries in the 1950s and 1960s to which Ghana was no exception.

Ghana has gone through several monetary and financial sector reforms with the prime aim of managing inflation and the value of the domestic currency to boost output growth. These reforms range from strict direct controls (fixed exchange rate, interest rate controls and ceilings, credit ceilings, and direct lending and capital controls) to monetary targeting and finally to inflation targeting which are an indirect control. After the adoption of the IT framework, which is aimed at controlling other monetary variables to achieve a targeted inflation rate, Ghana has been experiencing a lower inflationary environment when compared to the previous direct controls and monetary targeting policies. Inflation declined from 32.9% in 2001 to 10.91% in 2006 and 10.73% in 2007. Ghana from June 2010 to December 2012 enjoyed a single digit inflation rate

Several empirical literature on IT has come to the conclusion that inflation levels, volatility and persistence have declined after IT adoption (e.g. Bernanke et al, 1999; Corbo et al, 2001; Levin et al, 2004; and Mishkin and Schmidt-Hebbel, 2007). Kyereboah-Coleman (2012) in his work to ascertain the effectiveness of inflation targeting framework in the management of inflation in Ghana concluded that IT has had a significant impact on the reduction of inflation in recent years and has reduced the persistence of inflation series considerably. Taking the results of Kyereboah-Coleman (2012) and going by the logic of Taylor (2000) that a lower inflationary environment ensures a lower ERPT to domestic inflation and vice versa, the ERPT for Ghana is expected to decrease after the adoption of IT.

The global food and fuel crises coupled with loose fiscal and monetary policies in 2007 and 2008 and the recent depreciation of the cedi in 2012 has left Ghana with doubts as to whether IT has really decreased the ERPT to domestic prices since these two situations significantly impacted on domestic inflation thereby missing the inflation target set for 2008 by a very wide margin.

Such target missing dints the credibility of the monetary authorities thereby posing a great threat to efforts towards anchoring inflation expectations.

An estimation of the magnitude and nature of ERPT after the adoption of IT will help to accurately predict inflation thereby effectively anchoring inflation expectations in the medium term. This will also enable us to know if one major cause of inflation in Ghana as found by Bamumia and Abradu-Atoo (2003) and Sanusi (2010) has lost its effectiveness or not.

1.3 Objectives of the study

The main objective of this study is to estimate whether there has been a change in the magnitude and nature of the exchange rate pass-through to domestic inflation after the adoption of the inflation targeting (IT) policy framework by the monetary authorities of Ghana. The specific objectives of the study are as follows:

- To estimate the exchange rate pass-through for Ghana.
- To investigate the effect of Inflation Targeting Policy on the price level in Ghana.
- To test for Taylor's hypothesis by comparing the exchange rate pass-through for the periods before and after the adoption of inflation targeting by the monetary authorities in Ghana.

1.4 Hypothesis

The study is ultimately aimed at testing these hypothesis' informed by empirical and theoretical studies for confirmation or otherwise.

H_0 : exchange rate has no significant impact on the price level

H_1 : exchange rate has a significant impact on the price level

H_0 : inflation targeting policy framework has no significant effect of the price level

H_1 : inflation targeting policy framework has a significant effect on the price level

H_0 : inflation targeting has no significant impact on exchange rate pass-through

H_1 : inflation targeting has a significant impact on exchange rate pass-through

1.6 Significance of the study

There are several works that establishes a positive relationship between exchange rate and price levels. However, works to address the issue of the nature price level and ERPT after the adoption of the inflation targeting policy by the central bank of Ghana seem to be lacking in the literature. Coulibaly and Kempf (2010) in an attempt to ascertain whether inflation targeting decreases the exchange rate pass-through in emerging countries used panel VAR techniques and data for twenty-seven emerging countries (fifteen ITs and twelve non ITs) came to the conclusion that the adoption of IT has helped reduce the pass-through to all three price indexes (consumer price, import price and producer price) that they considered. Can one say same for the situation of Ghana? The role played by inflation targeting in the reduction of the pass-through is still not clear in the literature. This work therefore seeks to clear the uncertainty surrounding the impact of exchange rate on domestic inflation after the adoption of the IT framework by the monetary authorities of Ghana. An answer to this puzzling situation will be of much help to the monetary authorities in their decision making towards a favourable inflation rate. To this end, the result of the study will serve as a guide in the prediction of future inflation. When the impact of an expected depreciation on domestic inflation is known, prediction of future inflation becomes easier and gives the monetary authorities much more credibility.

1.7 Scope of the study

The study seeks to investigate the impact of the IT policy on inflation and exchange rate pass-through in Ghana. The study examines the empirical and theoretical implication of exchange rate pass-through and inflation targeting policy for developed and developing economies. Using the purchasing power parity with slight deviations, macroeconomic data on inflation, exchange rate, foreign inflation (USA), prime rate and money supply were used. A dummy variable and an interaction were included to account for the impact of the IT policy on inflation and exchange rate pass-through. The study was conducted at the macro level. The period 1995Q1- 2011Q4 was chosen for the study due to three important factors. These periods fall under one exchange rate policy regime (the interbank exchange rate market regime) and thus exonerate the results of the study from the effects of multiple exchange rate regimes. This system leaves the determination of the cedi to dollar exchange rate largely in the hands of the market. The period starts three clear years into the practice of democracy in the fourth republic and is therefore excused from political instability, thereby limiting the effect of political risk in the determination of exchange rate by the market. Lastly, the period have a fair representation of the pre and post inflation targeting policy and also is considered long enough to provide adequate information to the study.

1.8 Organization of the study

The study has been organized into five chapters. Chapter one is the introduction and it consist of the study background, problem statement, objectives of the study, hypothesis of the study, method of study and significance of the study. Chapter two reviews the relevant literature on exchange rate pass-through, inflation targeting and other related works. Chapter three discusses the method of study. Thus, the chapter highlights the econometric models used for the analysis and all analytical tests performed. Chapter four analyses the empirical results by applying the

econometric model to the data and interpreting the results. Finally, Chapter five concludes the study and gives recommendations based on the results.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature on the topic of the study. The first section reviews the theoretical framework of the study. The second section reviews the empirical literature on the topic. The third section reviews the empirical literature on the topic of the study. The fourth section reviews the empirical literature on the topic of the study. The fifth section reviews the empirical literature on the topic of the study.

2.2 Theoretical Framework

The theoretical framework of the study is based on the theory of the firm. The theory of the firm is a branch of economics that studies the behavior of firms. It is based on the assumption that firms are profit-maximizing entities. The theory of the firm is used to explain the behavior of firms in different markets. The theory of the firm is used to explain the behavior of firms in different markets. The theory of the firm is used to explain the behavior of firms in different markets.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature on inflation, exchange rate pass-through and inflation targeting. The first section reviews theoretical literature while the second section reviews the empirical works in relation to inflation, exchange rate and inflation targeting. The last section, section four, discusses the historical exchange rate regimes and its inflationary effect on the economy of Ghana.

2.2 Theoretical review

2.2.1 The concept of purchasing power parity (PPP)

Purchasing power parity (PPP), an important unresolved issue in international finance and economics, is defined as the ratio depicting the relative price level differences between two countries for a common good. This equates the exchange rate between two countries to the ratio of their price levels. According to the Princeton Encyclopaedia of the World Economy (2009), the long intellectual history of PPP can be traced to the 16th century writings of the University of Salamanca (Spain) but the modern definition was credited to Cassel (1918). According to Cassel "the money of different countries measured in the same unit should have the same purchasing power and should command the same basket of goods". The concept of PPP was and is still of relevance to the discipline of economics and international finance because of its role in determining relative value of a currency in terms of another currency and also for international comparison of GDP. Today the foundation of most theoretical models in international finance stems from the concept of PPP.

The law of one price (LOP) which gave birth to the concept of PPP states that identical goods in different markets will have the same price in the absence of other cost such as transportation and official trade barrier when prices are expressed in one currency. The law of one price with reference to the Ghana cedi and the US dollar is mathematically expressed as

$$P^{\text{¢}} = E_{\text{¢}/\$} * P^{\text{\$}} \quad (2.1)$$

where $P^{\text{¢}}$ is the domestic price of the good, $E_{\text{¢}/\$}$ is the cedi/dollar exchange rate and $P^{\text{\$}}$ is the foreign price of the good. Whereas the law of one price applies to one good or a group of commodities, PPP relation applies to the aggregate form for an entire economy through the use of price indexes such as CPI in place of the price of the good in equation (2.1). This can be mathematically expressed as:

$$P^d = E_{\text{¢}/\$} * P^f \quad (2.2)$$

Where P^d is the CPI for the domestic country, $E_{\text{¢}/\$}$ is the domestic / foreign currency rate (exchange rate) and P^f is the CPI for the foreign country. The assumption of constant prices but fluctuating exchange rate in the PPP equation forms the basis for using PPP as a determinant of exchange rates. This is because fluctuation of the exchange rate will now serve as a price equalizing factor between the two currencies. This form is called the absolute PPP. For the theory of PPP to hold, the CPI of both countries with respect to its components and base year must be identical. However, this condition is hard to meet because same goods are likely to have different weights in the computation of CPI in different countries. The nuisance or wrinkle associated with the adoption of absolute PPP brings us to an important concept called the relative PPP. Unlike absolute PPP, relative PPP relates the fluctuations in the price levels to that of the exchange rate therefore changes in the relative exchange rates are ascribed to the varying

inflation rates across the countries under consideration. Thus with the help of relative PPP, different basket of good with different weights attached to their components can be applied in explaining PPP thereby eliminating the errors associated with the theory. Relative PPP can be mathematically expressed as;

$$\% \Delta E_{\text{¢/\$}} = \% \Delta P^{\text{¢}} - \% \Delta P^{\text{\$}} \quad (2.3)$$

This equation shows that the percentage change in exchange rate ($\% \Delta E_{\text{¢/\$}}$) is equal to the difference in the percentage change in the cedi ($\% \Delta P^{\text{¢}}$) and that of the dollar ($\% \Delta P^{\text{\$}}$). Thus the difference in the percentage changes in the price levels of a country (say Ghana) and that of another country (say USA) is expressed as a direct determinant of the relative exchange rate which is the percentage change in the cedi dollar rates over a specified period of time.

The assumption of negligible transportation cost, taxation and tariffs, non inclusion of the cost of non tradable goods which partially accounts for the prices of commodities, firm's ability to price products differently across different markets and information asymmetry all contributes to the deviation from PPP. Nguyen (2005) concluded in his work that:

"regardless, it is important to understand that purchasing power parity is a powerful tool that provides us a common lens by which to view the economic health and condition of different countries. Just as with any tool or device, we must be cognizant of the limitations and weakness of PPP and understand how one can control those limitations within a particular data set".

Thus irrespective of the problems associated with the use of PPP for analysis, it is still of much relevance in our intellectual discourse.

2.2.2 The concept of exchange rate pass-through

The choice between fixed exchange rate and floating exchange rate sparked one of the longest lasting debates in the history of international finance and economics. In an era where fixed exchange rate and exchange rate targeting were the main monetary tools used to control economic fluctuations, Friedman (1953) and Johnson (1969) in advocating for flexible exchange rate both concluded that the flexible system of exchange rate would provide a better system of international adjustment. This was under the expectation that a floating system will lead to a stable equilibrium in the foreign exchange market unlike the failed Bretton Wood system. Against this premise the flexible exchange rate system was embraced after the break down of the Bretton wood system. The inability of the new system (flexible exchange rate) to resolve volatilities in the exchange rate and the exhibition of continuous resilience of trade balances of major trading nations led to a frantic academic effort to explain the adjustment puzzle. This has called for an investigation into the underlining relationships between exchange rate and prices of internationally traded goods and services, a concept today known as exchange rate pass-through.

Exchange rate pass-through, as defined by Goldberg and Knetter (1997), is the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries. Menon (1996) also opines that exchange rate pass-through is "the degree to which exchange rate are reflected in the destination currency prices of traded goods". Han and Suh (1996) as cited in Oladipo (2006) opined that "the percentage by which import prices, measured by the home currency, rise when the home currency depreciates is known as the degree of pass-through from the exchange rate to imported prices". All these definitions and views simply elaborate on how exchange rate fluctuations influence domestic inflation. The concept has its logical foundation from the PPP equation which

establishes a link between exchange rate, domestic prices and foreign prices. Exchange rate depreciation is known to be one leading cause of inflation in importing countries. The effects of exchange rate movements are transmitted to consumer prices via three major channels: (i) prices of imported consumption goods, (ii) domestically produced goods priced in foreign currency, and (iii) prices of imported intermediate goods (Sanusi, 2010). Exchange rate has a direct effect on prices in the first two channels but indirect in the second channel since it affects the cost of production which then is wholly or partially passed on to the final product. The pass-through from exchange rate to inflation can be divided into two stages, the first stage consists of exchange rate affecting the prices of imports and the second stage is the import prices affecting domestic inflation of the destination country (see Sahminan, 2002).

Many monetary models of the exchange rate assume a one-to-one relationship between the exchange rate and domestic prices, based on the law of one price (or purchasing power parity, PPP). However, almost all empirical literature concludes that the exchange rate pass-through is incomplete and that the pass-through from exchange rate to import prices turns to be greater, even though incomplete, than the pass-through to consumer prices. These findings have motivated numerous theoretical models aimed at explaining the incompleteness of the exchange rate pass-through.

K. Acheampong(2005) gave three factors accounting for this incomplete pass-through:

- *International Market Segmentation*: The pricing behavior of exporting firms can be used to explain the incompleteness of exchange rate pass-through. Krugman (1986) argues that for fear of losing market share, a large foreign supplier may not immediately raise or lower its foreign prices by the same percentage as the change in the exchange rate. If, however, exporting firms set prices in the currency of their production location (producer currency

pricing, PCP), exchange rate pass-through to import prices will be complete. In the model of Betts and Devereux's (1996), aggregate pass-through is dependent on the combination of firms practicing producer currency pricing (PCP) and local currency pricing (LCP). Third degree price discrimination has also been identified as a major factor accounting for the incompleteness of exchange rate passing through to domestic prices of destination countries.

- *Menu Cost:* Firms are not likely to change prices any time the domestic currency fluctuates unless the change is very significant because of the cost associated with changing of prices. Mankiw (1985) has shown that even small menu cost can have large effects on the economy.
- *Substitution by Consumers:* Burstein et al (2002) argue that substitution away from imports to lower quality local goods can account for the incomplete pass-through of exchange rate depreciation to domestic prices.

2.2.3 Inflation targeting framework

Bernanke et al (1999) defines inflation targeting as "a framework for monetary policy characterized by the public announcement of official quantitative targets for the inflation rate over one or more time horizons, and by explicit acknowledgment that low, stable inflation is monetary policy's primary long-run goal". New Zealand, the first country to adopt the IT framework, embarked on tight monetary policy which saw inflation falling in the latter part of 1980s as a measure to tackle the high volatile inflation in the 1970s and the early 1980s. The Reserve Bank Act of 1989 (Reserve Bank of New Zealand) which established the policy framework, what we call IT today, was introduced as part of a lasting solution to the crises in New Zealand. The following few years after the adoption of IT in New Zealand saw many central banks following suit as a pragmatic response to the failure of the existing monetary policies (exchange rate targeting and monetary targeting). Some 27 central banks were

considered fully fledged inflation marketers, while several others were in the process of establishing a full inflation-targeting regime as at the beginning of 2012 (Hammond, 2012). Hammond (2012) asserted that “inflation targeting is a recent monetary policy strategy that was forged out of the theoretical developments and practical experience that suggest that central banks cannot consistently pursue and achieve multiple goals such as low inflation, high growth (low unemployment) and a stable exchange rate through just manipulating the policy interest rate”.

In practice, an IT monetary policy has the following five distinguishing features compared to other monetary policy strategies: (see Hammond, 2012; Roger, 2010; Mishkin, 2004; Bernake *et al.*, 1999):

- central bank independence with respect to the tool of operation and political interference, together with an institutional commitment to price stability as the primary goal of monetary policy.
- the public announcement of medium-term numerical targets for inflation.
- monetary policy base on a wide set of information, including an inflation forecast. This should include many variables that describe both domestic and global conditions, and not just monetary aggregates or the exchange rate.
- transparency of the monetary policy strategy. Thus plans, objectives, econometric models and decisions of the monetary authorities should be effectively communicated to the public.
- increased accountability of the central bank for attaining its inflation objectives which includes explanations of the likelihood of attaining the target.

2.2.4 Inflation targeting in Ghana

The Bank of Ghana (BoG) in May, 2007 formally announced its adoption of formal inflation targeting (IT) after informally pursuing an IT regime since 2002 and became the second country in Sub-Saharan Africa after South Africa to formally announce its adoption of the IT policy. This placed a high responsibility of accountability of the BoG for its mandate of delivering price stability under the BoG Act (2002).

The IT framework practiced by the BoG had its operational independence from the BoG Act 2002 which allowed the BoG to use any of the instrument stipulated in the laws that governs their operations. The BoG sets a medium-term goal of 5% inflation with a $\pm 1\%$ band, along with some intermediate inflation-reduction targets. The target measure used is the headline CPI which targets a medium term of 18-24 months with the help of the prime rate as its key policy rate. The Autoregressive (AR) forecasting model, error correction forecasting model, macro econometric model and calibrated macroeconomic model (being developed) are the main models used by the BoG in forecasting of Inflation. Ghana currently has a target of $8.7\% \pm 2$ percentage points for 2012 and $8.0\% \pm 2$ percentage points for 2013. (see Gill Hammond (2012) for more details).

The adoption of IT has ensured a reduction in inflation from 32.90% in 2001 to 10.91% and 10.73% in 2006 and 2007 respectively creating a stable environment for the full commitment to IT policy framework. Few months after the BoG formally announced our commitment to IT, the global food and fuel price shocks coupled with domestic factors such as expansionary fiscal policy and loose monetary policies pushed inflation from 10.73% in 2007 to 16.52 in 2008 and further to 19.25 in 2009 leading to a negative real policy interest rate. Ghana's relief from the negative effect of the global crisis coupled with tight monetary and fiscal policies with strong

adherence to the IT framework saw Ghana's inflation falling from 20% at the beginning of 2009 to a single digit somewhere mid-2010 and to 8.6 percent by December 2010. On the other hand, inflation expectations have not been well anchored in Ghana and this reflects the history of high and volatile inflation. Inflation must be kept at a low level for an extended period of time if expectations about inflation can be successfully anchored. Ghana's growth, on the other hand, has been on an upward trend with few declines since 2002 hitting 14.3% in 2011 and therefore exonerates Ghana from the fear of adopting IT (low growth). (see Gemayel et al, 2011)

2.3 Empirical literature

2.3.1 Empirical literature on inflation and exchange rate pass-through

There are copious literature that establishes the existence and relevance of the ERPT both in developed and developing economies. This section reviews some landmark contributions to the ongoing debate on the relevance and nature of ERPT in modern international finance and economics.

Historically, the conventional knowledge on exchange rate-pass-through can be traced to Dornbusch (1976). Dornbusch showed in his studies that a onetime increase in the stock of currency will only leads to a temporal real depreciation but has no real effect in the long run. Real exchange rate was then perceived to create only temporal real effect and no effect at all on the underlining structure of the economy in models built in line with this tradition.

Baldwin (1988) was the first to challenge the results of Dornbusch (1976). Baldwin highlighted the idea that large exchange rate swings can leave a hysteresis that continues even after the cause that brought it has been removed. He showed that a sufficiently large temporal rise in the exchange rate influence foreign firms to enter the domestic market and with a sunk entry cost,

not all new entrant will exit the domestic market should the exchange rate return to its original level. Baldwin and Krugman (1989) and Dixit (1989) also came to a similar conclusion like that found in Baldwin (1988) that exchange rate shocks leave persistent effects in the economy.

With the exception of very few works, the empirical literature on the nature of the pass-through to both import and consumer prices unanimously concludes that pass-through is always almost incomplete for both developed and emerging economies. Rogoff (1996) noted that the law of one price has been tested and rejected by researchers for a variety of products and countries, using varying empirical methods and data source. Works such as Richardson (1978), Giovannini (1988) and Froot et al (1995) all documented deviations from the law of one price. Recent studies in this literature, including those by Campa and Goldberg (2002), Gagnon and Ihrig (2004), Fujii and Bailliu (2004), suggest that exchange rate pass-through is incomplete and has declined in recent years in industrialized countries. Bacchetta and Wincoop (2005), in a more recent controversial work constructed a model where foreign exporting firms sell intermediate goods to domestic firms who in turn assemble them and sell the final goods to consumers. They further demonstrated the extreme possibility that exchange rate pass-through to import prices is complete while the pass-through to consumer prices is almost zero.

For small very open economies, the evidence of the extent of pass-through remain mixed and inconclusive. Works like Athukorala (1991) for Korea, Leith (1991) for Botswana and Alexius (1997) for Sweden all gives evidence of incomplete pass-through while evidence for complete pass-through abounds in studies such as Kenny and McGettigan (1996, 1998) for Ireland, Asafu-Adjaye (1998) for Papua New Guinea and Kikuchi and Summer (2002),

Bhundia (2002) empirically investigated exchange rate pass-through in South Africa and came out with the evidence that the inflationary impact of exchange rate depreciation has been absorbed at intermediate stages of production. However, shocks to producer prices have tended to have a considerable impact on CPI (excluding interest on mortgage bonds). This they concluded in support of incomplete pass-through. Oladipo (2006) also examined the degree of pass-through from producer cost and exchange rate to prices of Nigerian imports from her major trading partners using the mark-up approach concluded that there exist a positive but incomplete pass-through to import prices. This work is consistent with the incomplete pass-through in the studies of Bhundia (2002). Evidently the two economic giants from Africa (South Africa and Nigeria) experience an incomplete pass-through indicating the absence of complete pass-through in some African economies.

Empirical works for Ghana unanimously concludes that exchange rate pass-through is real and significant but incomplete. The major disagreements on the nature of the pass-through for Ghana have to do with its magnitude. Chhibber and Shafik (1990) modelled inflation in the presence of an active parallel market due to exchange rate restrictions and found that official devaluation does not cause inflation. This he explained that most important prices (except petroleum prices) were already transacted at the parallel exchange rate market and therefore depreciation of the official exchange rate does not exert powerful inflationary pressures. They emphasized that inflation in Ghana is primarily a monetary phenomenon and that wage-cost inflation did not play a significant role in explaining the general price level. However, Dordunoo (1994) observes that rapid exchange rate depreciation and resultant hikes in import prices could not be ignored in explaining inflation since they are themselves inflationary. An alternative model to that of Chhibber and Shafik (1990) was provided in Sowa and Kwakye (1993). Using ordinary least

squares, all the possible causes of inflation in Ghana were specified: monetary, real factors and expectations. Inflation was explained by growth in money, exchange rate, real output and price expectations. Exchange rate devaluation appeared significant in the inflationary process contrary to the work of Chhibber and Shafik (2003) with supply constraint being the strongest force behind Ghana's inflationary push.

Bawumia and Abradu-Otoo (2003) in a simple theoretical model of price determination in Ghana modelled inflation as a function of money supply, expected inflation, the exchange rate and real output within an error correction framework. Using monthly data spanning the period 1983-1999, they found that inflation in Ghana is positively related to money supply and the exchange rate but negatively relates to real growth in the long run. The results showed that a 1% increase in M2+ (broad money) resulted in a rise in inflation by 0.41%, a 1% depreciation of the cedi resulted in a rise in inflation by 0.29% but a 1% increase in real income was expected to reduce inflation by 0.25%.

Acheampong (2005) using a recursive VAR framework and a monthly data from September 1997 to September 2004 empirically established the link between exchange rate and inflation in Ghana. Using the cumulative pass-through coefficient and the variance decomposition a modest and slow pass-through was found. This incomplete pass-through is in line with other studies on exchange rate pass-through. In the long run, only a little over 36% and 24% of exchange rate change show up in non-food price inflation and CPI inflation respectively and this occurs 28 months before returning to their initial level. After three months, 14.79% and 5.64% of the exchange rate change had already been reflected into non-food and overall consumer prices respectively. The pass-through after a year was 27.51% for non-food and 14.53% for CPI inflation. This he said means contraction of profit margin of firms and have the potential of

contracting output which in turn could lead to low employment and therefore makes exchange rate stability an important ingredient for economic growth. He also asserted that the modest and slow exchange rate pass-through satisfies one essential condition necessary for adopting inflation targeting framework in Ghana. The nature of the pass-through as established by Acheampong agreed with the findings of Bawumia and Abradu-Otoo (2003).

Acheampong (2005) again investigated Taylor's hypothesis for Ghana. The Taylor's hypothesis which says a lower inflationary environment results in a lower pass-through from exchange rate to domestic inflation was rejected for the situation of Ghana. Acheampong in an attempt to divide the sample into a higher and lower inflationary environment added the year 2000 (the year with the highest inflation in the sample) to the lower inflationary sample considered and this have the potential of arriving at spurious results. The proper estimation and testing of the Taylor's hypothesis will be necessary considering that Ghana today has a clear cut two periods of higher and lower inflationary environments, thus before and after inflation targeting.

Frimpong and Adam (2010) also using the Vector Autoregressive (VAR) model found an incomplete and decreasing exchange rate pass-through to inflation for Ghana which they said was consistent with findings in other African countries. Their empirical results indicate a low but significant pass-through in the short-run and this was attributed to the increased openness of the economy and tighter monetary policy pursue by the central bank over the period. In the long run, the coefficient of exchange rate was found to have no significant impact on inflation indicating a low/absence of exchange rate pass-through in the long run. Instead interest rate had a stronger impact on prices. These results contradicted that of Acheampong (2005).

Ocran (2007) in a recent study used the Johansen (1988) multivariate approach in modelling Ghana's inflationary experience with data spanning from 1960-2003. The findings identified exchange rate, foreign prices and terms of trade as determinants of prices in the long run. In the short run Ocran found inflation inertia to be the dominant determinant of inflation and this was followed by growth in money supply, changes in the treasury bill rates and the exchange rate. The result of the study showed that exchange rate, used as one of the nominal anchors in the pre-reform period is no longer prominent in the determination of inflation in Ghana especially in the short run. Excess money supply also had no significant impact on inflation in the long run. Ocran explained that money may have affected prices through other variables. His result is consistent with Bawumia and Atrah-Mensah (2003), who argued that inflation in Ghana is a monetary phenomenon.

Sanusi (2010) estimated the exchange rate pass-through to consumer prices for Ghana using the structural vector autoregressive (SVAR) approach which incorporated specific features of the Ghanaian economy, especially the central role of foreign exchange inflows in the conduct of monetary policy. Their results showed that exchange rate pass-through to consumer prices in Ghana are substantial but incomplete. Money supply shocks contribute relatively more to inflation than exchange rate shocks. Specifically, while exchange rate changes accounted for only 8 to 17% of the variations of the price level (at 1-16 quarters horizon respectively), money supply shocks accounted for about 3.3% to 22% at the same horizon respectively. This seems to support the general conclusion in the literature that Ghana's inflation process has been a monetary phenomenon. This contrasted the low pass-through evidence by Frimpong and Adam (2010). Sanusi argued that the findings of Frimpong and Adam (2010) were puzzling given Ghana's history of massive exchange rate depreciation that coexisted with high inflation and

attributes the large pass-through to the continues depreciation of the cedi and high persistent inflation during the period under consideration. The sample duration of 1983:Q3 through to 2006:Q3 by Sanusi (2010) is characterized by higher depreciation of the cedi and higher inflation whiles that of Frimpong and Adam (2010) which spurns from 1990:Q1 to 2009:Q2 is characterized by relatively lower depreciation and inflation rates. What appears to be a methodological criticism from Sanusi (2010) cannot be wholly accepted because Taylor (2000) and Choudhri and Hakura (2001) provide us with some empirical evidence that the inflationary environment have some influence on the nature and magnitude of the pass-through. Thus high inflation environment is likely to result in a high pass-through as compare to a lower inflationary environment.

Adu and Marbour (2011) in a recent study on determinants of inflation using ARDL approach to cointegration for the period 1960-2009, confirmed the significant role of real output, nominal exchange rate, broad money supply, nominal interest rate and fiscal deficit in explaining inflation in Ghana. Real output and exchange rate had a negative significant long run nexus with inflation whiles money supply and interest rate had a positive nexus with inflation. To them, the negative unpopular exchange rate-inflation nexus for Ghana can be attributed to exchange rate scarcity in the 1970's resulting in the substantial transactions occurring at the parallel market as found in Chhibber and Shafik (1990) for Ghana and Ndung'u (1997) for Kenya.

2.3.2 Empirical assessment of inflation targeting policy framework

Empirical works assessing the performance of IT abound in the literature. The performance of IT with respect to inflation, inflation expectation, output and the recent financial crises remain inconclusive with majority of the literature in favour of inflation targeting as the best compared to the other tools such as money-growth targeting and exchange rate targeting.

Money-growth targeting which use to be one of the tools used by most central banks before the introduction of IT has been abandoned. This was due to the unstable and unreliable relation between money growth and inflation hindering the efficacy of money-growth targeting in ensuring inflation stability. Germany's Bundes Bank was described as an implicit inflation targeter at a time they were officially practicing money-growth targeting for many years because it often deliberately missed money-growth target in order to achieve its inflation target thereby behaving in a way that places inflation targeting before monetary targeting (see Svensson (1999c, 2009d) for a discussions on this point).

- **Inflation targeting and inflation**

Works such as Gonclaves and Salles (2008), Mishkin and Schmidt-Hebbel (2007), Levin and Swanson (2006), and Bernanke *et. al.* (1999) have found that IT successfully reduces inflation and makes it less volatile and persistent for both industrialized and emerging economies and also anchors long run expectations at or very close to the inflation target.

Research from the International Monetary Fund (2005) also came out with a result that “inflation targeting appears to have been associated with lower inflation, lower inflation expectations and lower inflation volatility relative to countries that have not adopted it”. They also claimed that these improvements in inflation performance were achieved with no negative effects on output and interest rate volatility. In assessing the performance of monetary policy frameworks in the midst of the recent financial crises, the IMF found that IT seemed to be more effective than alternative monetary policy framework in anchoring expectations. (see IMF *World Economic Outlook*, Summer 2005 and ~~October~~ 2008)

According to Greenspan (1994), price stability is attained when households and businesses need not factor expectations of changes in the average level of prices into their decisions. Thus an IT policy perceived to be credible by economic agents results in the anchoring of expectations to a target that may reduce the variance in relative prices, which in turn can reduce the level of inflation (Ball and Mankiw, 1995). Going by the same logic, Orphanides and Williams (2005) explained that firms and individuals are likely to rely on expected inflation in pricing their products and this may result in inflation being less persistent.

Levin *et al* (2004) examined the extent to which expected inflation moves in response to economic news and found some evidence that inflation persistence is lower, and expectations better anchored, in inflation-targeting countries.

Crujsen and Demertzis (2010) used a bivariate VAR model involving inflation and expected inflation and demonstrated that under conditions of perfect credibility, monetary policy has succeeded in breaking the link between actual inflation and long run expectations of inflation for a group of member countries belonging to the European Union (EU). IMF (2008), as cited in Svensson (2009) considered which monetary-policy frameworks had been most successful in anchoring inflation expectations in the wake of the oil and food price shocks in 2007, and found that “in emerging economies, inflation targeting seems to have recently been more effective than alternative monetary-policy frameworks in anchoring expectations.”

Contrary to the claims by the advocates of IT, Ball and Sheridan (2003) compared monetary policy outcomes in OECD countries and discovered that countries with a history of high inflation before the 1990s also experienced a larger degree of disinflation as compared to countries with a history of low inflation and argued that “once one controls for regression to the mean, there is no

evidence that inflation targeting improves performance". Angeriz and Arestis (2008) also applied an intervention analysis to multivariate structural time series models to a number of OECD countries and demonstrated that both the IT and the non-IT central banks have been successful in achieving low inflation rates.

From the above works reviewed for different countries using different methods it is clear that IT is hailed as the best monetary policy to tackle inflation today when compared to other policies such as monetary growth targeting and exchange rate targeting.

- **Inflation targeting and the real economy.**

The main concern with inflation targeting by its sceptics was that other important macroeconomic goals such as growth and output gap would be neglected as central banks targets only inflation (see Friedman and Kuttner, 1996; Cecchetti and Ehrmann, 2002; Friedman, 2004). The existing theory by Rogoff (1985) before the coming into being of IT in New Zealand implied that giving more attention to controlling inflation would result in a lower average inflation but with a cost in the form of greater volatility in the real economy and this gave much reason for economic worries.

Whiles the experience by developed economies have shown that there is not much difference in the macroeconomic performance of inflation targeting and non-inflation countries, that of developing countries shows that IT has helped improve macroeconomic performance contrary to the fears of Rogoff (1985). Divino (2009) examined the effectiveness of inflation targeting in reducing unemployment, output gap and fostering economics growth by comparing inflation targeting countries to non-inflation targeting countries using the difference-in-difference approach concluded that targeting countries, on average, were able to reduce the unemployment

rate by about 5% and narrowed the output gap by about 1% in the post-targeting period relative to non-targeting countries. However, the results showed that inflation targeting regime did not help improve the countries' performance in terms of achieving higher average economic growth but one should also note that it neither concluded that IT adversely affected growth.

Brito and Bystedt (2010) in their work confirmed the fears of Rogo (1985) that inflation targeting and its associated lower average inflation comes with the cost of lower growth by finding a significant negative effect of inflation targeting on average growth.

Theoretically, the adoption of IT may positively or negatively affect output volatility, however, the empirical effect found is one of reduced output volatility, if at all significant, even though there are few works that suggest otherwise. Goncalves and Salles (2005) find that IT reduces output volatility, while Batini and Laxton (2006) and Naqvi and Rizvi (2009) did not find any significant effect of IT on output volatility and growth respectively.

Mollick et al (2011), considered 34 emerging markets and 22 industrialized economies with the help of a dynamic panel data analysis examine the output growth and found that IT regimes generate higher output growth for both industrialized and emerging economies. However, the output growth for emerging economies were relatively lower than that found in industrialized economies. They therefore argued that this may be due to their having adopted IT much later than industrialized economies.

- **Inflation targeting and the 2007 global crises.**

In the face of the crisis in 2007 through to 2009, some skeptics expressed doubts about the ability of IT to exhibit resilience to the various economic pressures faced by most central banks in hard

hit countries. One of such skeptics was Stiglitz (2008) who wrote that “today, inflation targeting is being put to the test –and it will almost certainly fail” (Stiglitz 2008).

Inflation targeting (IT), which was widely accepted as a successful policy framework prior to the 2007 crises is still hailed as the best in most recent works that attempted to assess its performance during and after the crisis. Such works includes Rose (2007), Walsh (2009a), Roger (2010) and Carvalho-Filho (2010). Carvalho-Filho (2010) found that IT countries appear to have been more suited to dealing with the 2007 global crisis in relation to non IT countries. IT countries were found to have lowered nominal policy rates relative to non IT countries and this translated into an even larger differential in real interest rates. With the nominal policy rate serving as a monetary stimulus, IT countries on average performed better than their non IT counterparts. Roger (2010) and IMF (2008) also finds that inflation-targeting countries proved resilient in the financial crisis.

Tapsoba (2010) on the effects of inflation targeting on fiscal discipline (FD) for 58 countries (comprising of 22 inflation targeting countries and 36 countries targeting either money Growth or exchange rate) covered the periods 1980-2003. The study which covered both developed and developing countries concluded that the adoption of the IT policy, relative to money targeting or exchange rate targeting, does not improve central government FD on the total sample but observed that the positive effect of IT on FD takes place only in developing countries sub-sample where seigniorage still represents a substantial source of government finance.

Mishkin and Savastano (2001) and Savastano *et al* (1997) noted that IT by itself is not capable of preventing fiscal dominance but rather must go hand in hand with fiscal discipline. Thus for IT to be successful, fiscal discipline must be practiced. Goals such as low inflation and anchoring of

expected inflation can never be achieved merely by the adoption of IT. This finding they argued is of particular relevance to emerging economies where the risk of fiscal dominance arises.

- **Inflation targeting and exchange rate pass-through.**

The adverse effects of ERPT have led to countries adopting several measures to ensure they are exonerated from this negative economic effect. Efforts such as stabilizing their currency, reducing imports as much as they can, Building much foreign reserves to support their currency in times of crises, considering a reduction of import duties on producing companies that import raw materials for production, etc. Also monetary policies such as fixed exchange rate system or a dual exchange rate systems such as the one practiced by Ghana in 1986 has been historically adopted by many nations, especially developing nations, to deal with their pass-through problems. The recent solution to reducing ERPT according to Taylor (2000) lies in the stable and low inflationary environment. Recent literature also shows that a stable and low inflationary environment is best achieved by the adoption of IT (see Gonclaves and Salles, 2008; Mishkin and Schmidt-Hebbel, 2007).

For fear of losing their market share as found in Krugman (1986), importing companies in a low inflationary environment will be reluctant to pass on all the cost of depreciation of the local currency to their final goods. One will therefore not be out of order to logically conclude from the works mentioned above that IT adoption result in the reduction in the ERPT. These logical conclusions have been solidified by many empirical works conducted to prove that IT adoption has led to the reduction of ERPT in many advanced and emerging economies.

Coulibaly and Kempf (2010) in an attempt to ascertain whether inflation targeting decreases the exchange rate Pass-through in emerging countries used panel VAR techniques and data on

twenty-seven emerging countries (fifteen ITs and twelve non ITs) came to the conclusion that the adoption of IT has helped reduce the pass-through to all three price indexes (consumer price, import price and producer price) that they considered. Also Edwards (2007), and Mishkin and Schmidt-Hebbel (2007) in their separate works found some evidence that IT adoption has reduced the pass-through of exchange rate shocks to inflation. Devereux and Engel (2003) argues that if exporters practice local currency pricing (setting of prices in the destination country's currency) in countries that have stable monetary policy, as oppose to producer currency pricing (setting prices in the currency of the producing country), the ERPT into import prices will be low for countries with stable and low monetary and exchange rate variability.

Garcia and Restrepo (2001) and Schmidt-Hebbel and Werner (2002) with the help of a simple correlation analysis (with lags) estimated the relationship between inflation and domestic currency depreciation (degree of exchange rate pass-through effect into inflation) and showed that the pass-through for Brazil, Chile and Mexico during the 90's have substantially reduced. This they observed comes a decade after all these countries adopted the IT framework.

Civcir and Akçağlayan (2010) in a study to investigate how monetary policy responds to shocks emanating from exchange rate movements before and after adoption of inflation targeting policy found that the implementation of IT has resulted in a weak and slow pass-through as compared to the high pass-through in the pegged system practiced before IT. Reyes (2007) using a simple theoretical model came out with an additional channel through which ERPT can be reduced under an inflation targeting regime. His results showed that the decline in ERPT in emerging markets under an IT regime may be a consequence of the fear of floating. Thus the central bank often intervene in the exchange rate market under IT because they fear that if left unconcern the market will not function well to maintain the value of the currency. Reginaldo (2007) estimated

Table 2.1 below shows the exchange rate episodes in Ghana at each material moment of our economic history. Ghana adopted a fixed exchange rate regime from 1957 to 1982 in the management of its exchange rate and has since 1983 worked towards a floating system of exchange rate. The system of fixed exchange rate from 1957 to 1982 was one supported by the Bretton Woods system and also consistent with the thinking of the time.

Table 2.1 Exchange rate policy episodes in Ghana

Episodes	Duration	Policy
1	1957 – 1966	Fixed to the British pound
2	1966 – 1982	Fixed to the American dollar
3	1983 – 1986	Multiple exchange rate system
4	1986 – 1987	Dual exchange rate system-auction determined dual retail auction system.
5	1987 -1988	Dutch auction system
6	1988 – 1989	Foreign exchange bureau
7	1990 – 1992	Wholesale and inter-bank auction system
8	1992 –	Inter-bank market. The bank of Ghana (BOG) selling and buying rates were determined by the average daily retail rates of the Commercial banks.

Source: Bank of Ghana, IMF

This system was unique in that it was not maintained by active interventions in the foreign exchange market as practiced by most market economies at the time and this was due to the inheritance of huge foreign exchange reserves from the colonial era. In this system the cedi was pegged to the convertible currencies, i.e. the British Pound (1957–1966) and the American Dollar (1966–1982) by a decree with some administrative controls such as the issuance of import licenses instituted to deal with any possible excess demand for foreign currencies.

The inflation rates from 1957 to early 1970's were relatively low with few years such as 1965 recording very high rates of inflation (26.4%). Inflation was particularly high and volatile during the political turbulence of 1970s and early 1980s. Inflation as at 1970 was 3.9%. This was due to marked domestic output growth and improved import supplies due to the cocoa boom in 1970. However, the import liberalization policy and the precipitous fall in the world market price of cocoa in 1971 combined to cause a rapid decline in the country's foreign exchange reserves, putting undue pressure on the fixed exchange rate leading to balance of payments difficulties. As a result, the low rate of inflation in 1970 could not be sustained and this rose to 9.3% in 1971. From 1972 onward, inflation gathered momentum and it has been described in the political parlance as a period of "acceleration towards the abyss". The rate of inflation increased persistently between 1972 and 1977. Inflation hit its all-time high figure of 122.8% in 1983, the highest since independence. This resulted from the intensive drought and bush fires which destroyed large quantities of food crops in 1983 thereby creating acute food shortage in the country.

The passive attitude towards exchange rate management (fixed exchange rate) played a key role in the economic problems experienced in Ghana in the late 1970's and early 1980's which led to Ghana subscribing to the economic recovery program (ERP). As part of the economic recovery program (ERP), the government embarked on series of devaluations which saw the cedi devalued from ₵2.75: US\$1.00 in 1983 to ₵90.00: US\$1.00 by the third quarter of 1986. This new regime was characterized by a scheme of bonuses on exchange receipts and surcharges on exchange payments. A two-window exchange rate system characterized by two official exchange rates of ₵23.38: US\$1.00 and ₵30.00: US\$1.00 was also introduced. A more periodic exchange rate devaluation was adopted in accordance with the relative inflation rates of our major trading

partners in December 1984 to replace the old policy of quarterly adjustment mechanism adopted between 1983-1984 because the real exchange rate was thought to be overvalued.

Within three years of the Economic Recovery Programme (ERP), the devaluation of the cedi translated into some depreciation of 93.67%, 13.16%, and 16.67% in 1983, 1984 and 1985 respectively. This resulted in an all-time high inflation of 122.8% in 1983 which subsequently dropped to 40.2% in 1984 and further fell to 10% in 1985. The average annual inflation rate for the periods 1980-1983 was 77.93% while that of 1984-1986 was 24.84%. This shows the positive effect of the Economic Recovery Program and its associated new devaluation policies on inflation.

Exchange rate management policies of Ghana took up a new face in 1986 by partially allowing the market forces of demand and supply to influence the rate. Thus Ghana moved to an era of managed float exchange rate system with some intervention from the BoG. The Bank of Ghana's intervention in the foreign exchange market has been mainly to smoothen fluctuations in the foreign exchange market (BoG). Thus an auction market approach to accelerate the adjustment of exchange rate and to achieve the objective of trade liberalization was adopted in September 1986. This new arrangement was characterized by a new two window system. Window one, which applied to earnings from the export of cocoa and residual oil products was operated as a fixed exchange rate system with a pegged cedi-dollar exchange rate of ₵90.00: US\$ 1.00 while the second window for all other transactions was left to the forces of demand and supply in a weekly auction conducted by the BoG. This resulted in an increased depreciation of the cedi, from 16.67% in 1985 to 33.33% in 1986 and further to 48.86% in 1987 signalling an initial overvaluation of the cedi. A dual-retail auction based on the marginal pricing system which required successful bidders to pay the marginal price was adopted. A second auction - the Dutch

auction - was introduced in 1987 - 1988 and under it, successful bidders were supposed to pay the bid price. The inflationary pressures in this era started gathering some momentum moving from a lower rate of 10.30% in 1985 to 24.56% in 1986 and further to 39.81% in 1987 reflecting the trend of depreciation of the cedi. This fell to 31.35% in 1988 with a lower depreciation rate of 23.48% but was still higher than the previous era of the fixed but devaluated exchange rate regime in the face of ERP from 1983 to 1985.

The fixed exchange rate system with its tight regulations saw the emergence of a large uncontrollable parallel market where foreign currencies were sold at higher prices. In an attempt to absorb the activities of the parallel market into the legal foreign exchange market to ensure that the monetary authorities have accurate records of all forex transactions in the economy, the foreign exchange bureau system was established in 1988. These forex bureaux were privately operated by individuals, groups or institutions with a license and were not allowed to bid for foreign exchange in the weekly-retail auction. Inflation in that year was still high at 31.35% and fell to 25.22% in 1989. These were relatively lower than that of the previous years.

A new composite wholesale auction system namely the inter-bank and a wholesale system was introduced in March 1990 to replace the weekly retail auction. This system allowed eligible Forex Bureaux and authorized dealer banks to purchase foreign exchange from the bank of Ghana, selling them to their end user customers subject to a margin determined by each authorized dealer and meeting their own foreign exchange needs. Inflation was 37.25% in 1990 with a depreciation rate of 12.17% and 18.03% in 1991 with 11.54% depreciation. This era did not experience much depreciation since the cedi had depreciated enough and had almost attained its market value.

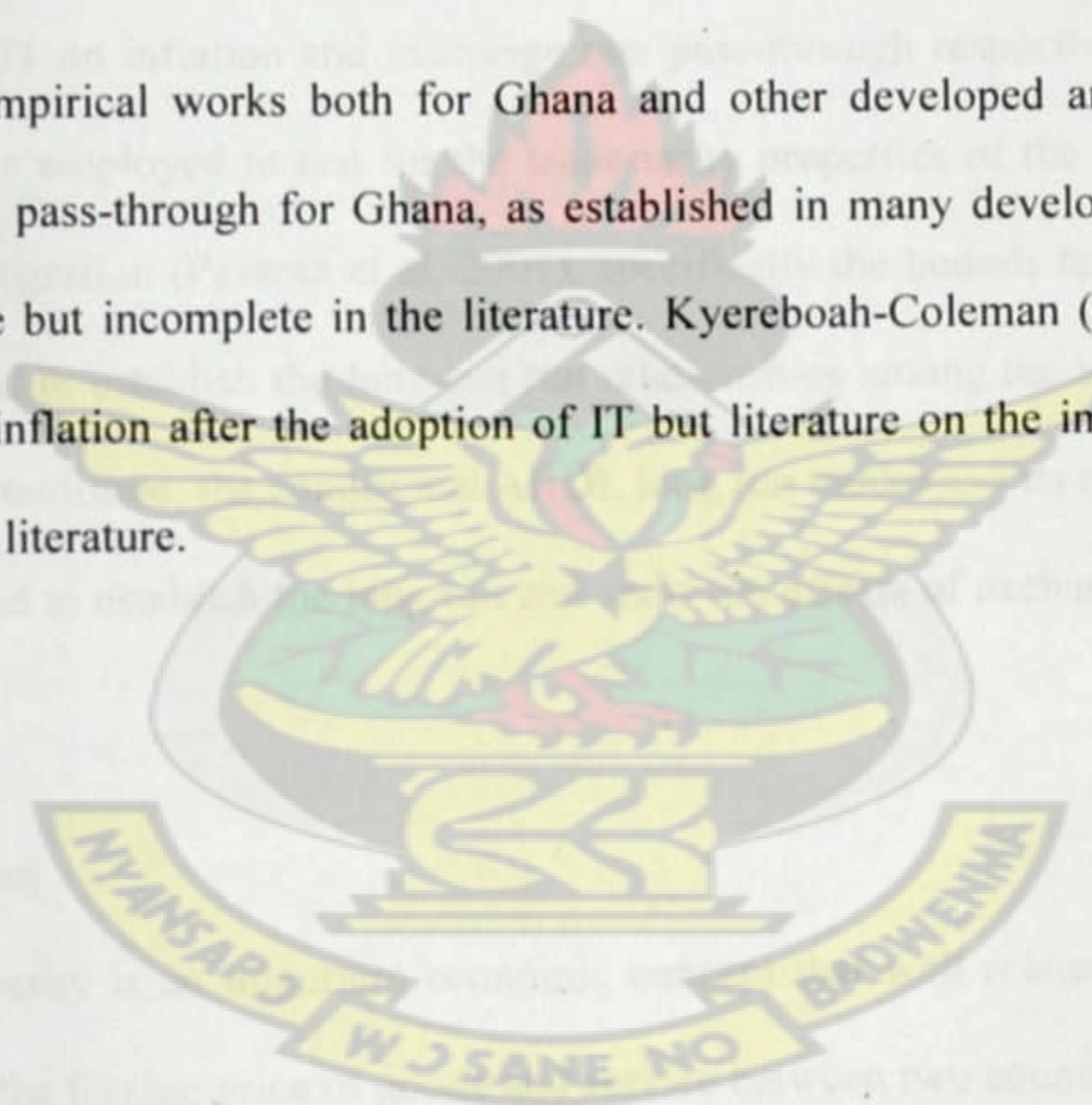
The introduction of an inter-bank market which has been maintained till date saw the abolishment of the wholesale system in April 1992 where both the commercial banks and forex Bureaux operated in a competitive environment. This led to a more liberal and floating system of exchange rate which saw the cedi depreciating further to attain its real market value. The depreciation was 25.00% and 36.76% in 1992 and 1993 respectively. This saw inflation increasing from its low value of 10.26% in 1991 to 13.33% and further to 27.66% in 1992 and 1993 respectively. Depreciation continued to remain relatively higher at an annual average of 22.17% between 1993 and 1997 with inflation following the trend of deprecation at an annual average of 39.62% in the same period. With tight fiscal policies and prudent economic management the year 1998 experienced 4.07% depreciation and a corresponding inflation rate of 15.7%. Unfavourable changes in the world market prices of Ghana's major trading commodities brought untold pressure on our currency. A rise in the price of crude oil coupled with a fall in the price of cocoa on the world market coupled with an election year excess spending brought depreciation from its low value of 4.07% in 1999 to about 49.8% in 2000 with a corresponding movement in inflation from its 15.7% rate to over 40.5% in the same period. The new focus of a price stability policy in Ghana by the new government in 2001 saw inflation declining from 40.5% at the end of 2000 to 21.3% in 2001 and 15.2% in 2002. This continuous decline in the CPI was not sustained due to a 100% increase in petroleum prices and a huge demand for an increase in wages leading to an increase in inflation to 23.4% in 2003.

The adoption of an inflation targeting policy in 2002 by the monetary authorities coupled with the prudent fiscal management policies pursued by government witnessed a continuous decline in inflation between 2004 and 2007. Inflation dropped from 23.4% in 2003 to 18%, 15.4% 11.7% and 10.7% in 2004, 2005, 2006 and 2007 respectively with the cedi depreciating at a very low

single digit rate. This could not be sustained due to the Global financial and world food crises which started somewhere in 2007 the food inflation and prices of imported food in Ghana rose affecting our domestic inflation. This also saw a higher depreciation of the cedi as compared to the previous years. The 2008 and 2009 inflation rates rose to 16.5% and 19% respectively. With extra tight fiscal and monetary management, Ghana for the first time in three decades was able to attain single digit inflation by reversing the increasing inflation rates from 19% in 2009 to 10.75 and 8.73 in 2010 and 2011 respectively.

2.5 Conclusion

The chapter reviewed empirical works both for Ghana and other developed and developing countries. Exchange rate pass-through for Ghana, as established in many developed countries, was found to be positive but incomplete in the literature. Kyereboah-Coleman (2012) found a reduction in the rate of inflation after the adoption of IT but literature on the impact of IT on ERPT was lacking in the literature.



CHAPTER THREE

METHOD OF STUDY

3.1 Introduction

This chapter deals with the modelling technique adopted to achieve the objectives of the study. Using the purchasing power parity with slight adjustments to suit the situation of Ghana, the study developed two models for estimation. The first model is mainly to determine the general impact of exchange rate on inflation. The second model which contains a dummy variable representing IT regime and an interaction term (dummy variable and exchange rate) was used to determine the impact of IT on inflation and exchange rate pass-through respectively. ADF and the PP unit root test were employed to test for the stationarity properties of the variables. The ARDL approach to cointegration (Pesaran et al, 2001), specifically the bounds testing approach to cointegration, was used to establish the long-run relationships among the variables. After cointegration has been established, the conditional ARDL long run model and its respective error correction model was used to establish the long run and short run effects of exchange rate and IT on inflation.

3.2 Theoretical modelling.

The purchasing power parity is an important economic concept that well relates the exchange rate, domestic price and the foreign price of goods and service between two countries. Under this concept the exchange rate adjust to ensure that identical goods in two different countries have the same price when expressed in a common currency. This concept perfectly relates the exchange rate between two countries and the domestic price of that country with respect to imports. This relation is therefore used to mathematically establish a strict link between prices and exchange rate. Consider the PPP relation:

$$e = \frac{p^d}{p^f} \quad (3.1)$$

Where e , the nominal (dollar) exchange rate is expressed in domestic currency, p^d and p^f are the domestic and foreign price levels respectively. Equation 3.1 simply shows that the exchange rate between any two countries is a function of the ratio between and domestic price of goods and services to the foreign price of those same goods and services. This equation can be rearranged to fit the price-exchange rate relationship by taking the log of the entire equation and making domestic price the dependent variable.

$$\ln p^d = \beta \ln e + \delta \ln p^f + \mu \quad (3.2)$$

where $\ln p^d$, $\ln p^f$ and $\ln e$ are the logs of domestic prices, foreign prices and exchange rate respectively. β and δ are the coefficients of the nominal exchange rate and foreign price respectively and as such represents the elasticity of domestic prices with respect to the independent variables they precede. μ is the error term. Equation 3.2 above establishes a clear simpler relationship between domestic price, exchange rate and foreign prices. The law of one price implies that $\beta = \delta = 1$. Thus changes in exchange rate completely pass-through to the domestic price of traded goods and services. Thus a one percent change in the exchange rate or foreign price of a good or service will result in a one percent change in domestic price, all other things being equal. This forms the basis for analyzing the long run pass-through to enquire the percentage of exchange rate pass-through to domestic inflation in the long run.

3.3 Model specification

Following McFarlane (2002), and Parsely and Popper (1998), the work extends the expression in equation 3.2 by introducing an interest rate (prime rate) to take account of the behaviour of the

central banks as depicted in the work of Frimpong and Adam (2010). This is in support of the argument of Bernanke and Mihov (1997) that most central banks in the world by now target short-term interest rates as a way of ensuring macroeconomic stability. Also money supply which is an important contributor to inflation in Ghana according to Bawumia and Abradu-Otoo (2003) will be included in the model as an independent variable to give an appreciable account of what drives inflation in Ghana. The model then becomes:

$$\ln p^d_t = \alpha + \pi \ln m_t + \gamma \ln pr_t + \beta \ln e_t + \delta \ln p^f_t + \varepsilon_{it} \quad (3.3a)$$

where $\ln m$ is the log of money supply and $\ln pr$ is the log of the monetary policy rate, that is, the prime rate of the domestic country.

In an attempt to test for the effectiveness of inflation targeting in the reduction of inflation, Taylor's hypothesis is adopted. This hypothesis says that after the adoption of inflation targeting, the economy begin to enjoy a lower inflationary environment. We therefore include a dummy variable to capture the periods before and after the adoption of inflation targeting. This gives us another equation for estimation. An interaction term between the dummy variable and exchange rate is also introduced to establish the impact of IT on exchange rate pass-through. The corresponding equation is:

$$\ln p^d_t = \alpha + \pi \ln m_t + \gamma \ln pr_t + \beta \ln e_t + \delta \ln p^f_t + \phi d_t + \theta d \ln e_t + \nu_{it} \quad (3.3b)$$

where d_t is a dummy variable defined as $d_t = 0$ from 1995Q1 to 2002Q1 and 1 from 2002Q2 to 2011Q4. $d \ln e_t$ is the interaction(multiplication term) between the dummy variable and the log of exchange rate. ϕ and θ are the coefficient of the dummy variable and the interaction term respectively.

The stability tests, to scrutinize the stability of ARDL bounds testing estimates, is applied, ie. CUSUM and CUSUMSQ (Brown et al. 1975). Also the diagnostic test for Normality, functional form and serial correlation is tested using the F-statistics and the probability values generated.

According to Stocks and Watson (2007), log transformation transforms the variables into percentage form thereby permitting the model to estimate the percentage change in the dependent variable due to a percentage change in the independent variable. Gujarati (1995) also asserts that log transformation helps reduce the scales of measure of the variables from the tenfold to a twofold thereby reducing the problem of hetereskedasticity. These two reasons combined bring the value of all variables to the same unit and also makes it possible for interpretations to be done in percentage elasticity form. The addition of money supply with large values and different variables with different units of measurements therefore justifies the reason for log-linear model.

3.4 Types and sources of data

Quarterly data on domestic price level, money supply, monetary policy rate (prime rate), nominal exchange rate and foreign prices level was used for the estimation. The domestic prime rate was used to reflect the behaviour of the Bank of Ghana (BoG). The consumer price index (CPI) was used to represent the domestic price level while the consumer price index of the United States of America was used to represent foreign price level. Total liquidity (M2+) was used to represent money supply which happens to be a major contributor to inflation in Ghana. The cedi to dollar interbank exchange rate was used to represent nominal exchange rate. Data used covered the periods 1995Q1 to 2011Q4, making a sample size of 68 for the estimation. Data on nominal exchange rate, monetary policy rate, money supply and consumer price level was sourced from BoG while data on foreign prices (US prices) was sourced from the U.S. Bureau

3.5 Description and a priori expectation of variables

- **Consumer price index**

Consumer price index measures the weighted average prices of a market basket of consumer goods and services purchased by households. The CPI sometimes referred to as headline inflation, can be used to assess price changes associated with the cost of living. The CPI used in this study as calculated by the Ghana Statistical Service (GSS) measures the change over time in the general price level of goods and services that households acquire for the purpose of consumption, with reference to the price level in 2002, the base year, which has an index of 100 (GSS, 2013)

Two basic data are needed to calculate the CPI, thus is price data and weighting data. The price data are collected from a basket of consumable goods and services from a sampled of locations for a specific period of time while the weighting represents an estimate of the share of different types of expenditure in the total expenditure covered by the index. These weights are usually based on expenditure data obtained from expenditure surveys for a sample of household or upon estimates of the composition of consumption expenditure in the national income and product accounts (US Bureau of statistics, 2012). This therefore reflects the relative importance of the commodity in the consumption expenditure of households. The CPI is calculated by taking price changes for each item in the predetermined basket of goods and services and averaging them; the goods are weighted according to their importance. $CPI = \sum_{i=1}^n CPI_i * weight_i$, where $weight_i$ sums up to 100, i is the i th commodity and n is the number of commodities considered in the basket of goods and services.

Domestic CPI is the dependent variable in the model and this is affected by other variables or factors as confirmed by theory and empirical studies. Sanusi (2010) identified money supply and exchange rate as the two main determinants of price levels whiles Bawumia and Abradu-Otoo (2003) discovered exchange rate, money supply and real GDP growth as the main determinants of price level in Ghana. Adu and Marbour (2011) also identified money supply, exchange rate, interest rate and economic growth as the main determinants of inflation. Frimpong and Oteng-Abayie (2010) in an attempt to investigate the harmful nature of inflation on economics growth concluded that there exists a threshold effect of inflation on economic growth. Their results indicate inflation threshold level of 11% at which inflation starts to significantly hurt economic growth in Ghana. This makes it difficult to determine the real effect of growth on prices since the periods considered have an almost equal mixture of above and below 11% rate of inflation.

- **Foreign consumer price index**

This is a measure that examines the weighted average of foreign prices of a basket of foreign consumer goods and services. This is defined by the US bureau of labour as “a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services”. The same procedure of calculating the domestic CPI is followed with little deviation pertaining to the weights and content of basket. From the purchasing power parity, an a priori expectation of a positive coefficient for foreign CPI is expected as in the work of Frimpong and Adam (2010).

- **Exchange rate**

Exchange rate is the price for which the currency of a country can be exchanged for that of another country. A system of exchange rate practiced can either be one of pegged where the government or an authorized body legally pegs the exchange rate to a foreign currency or a

floating regime where the forces of demand and supply of the currencies involved as well as the amount of foreign currency held as reserves determines the day to day rates in the foreign exchange market. Other factors such as interest rate, inflation, trade balance and political stability also can influence exchange rate. The exchange rate regime practiced by Ghana since 1995 can be described as a managed float, also known as dirty float. This system is a mixture of floating system and attempts by the central bank to influence the rate through buying and selling of currency. The exchange rate used is the interbank exchange rate from the interbank forex market. The interbank forex market, also referred to as the forex wholesale market, is where banks exchange currencies directly with other banks. Most currency transactions in Ghana are performed here and are less regulated, decentralized and better responds to the forces of demand and supply.

From the Purchasing power parity, exchange rate is expected to have a positive relationship with domestic price, holding foreign prices constant. An increase in the exchange rate, also known as depreciation, results in an increase in the price of imported goods and services. Since import prices forms a significant aspect of our price level calculations this end up increasing the domestic price level in the economy. It therefore expected that the coefficient of exchange rate in our model will have an expected positive sign.

- **Money supply**

Money supply is the amount of money circulating in the system. This can be found in different degrees of liquidity. This work uses total liquidity which consist of narrow money (currency notes and coins), broad money (narrow money plus deposits in checking accounts, savings accounts, small time deposits, commercial bank overnight repos and non-institutional money

market accounts) and all other assets and instruments that can be converted into a liquid form with time.

The quantity theory of money, an economic theory developed in the sixteenth century by European economist proposes a positive relationship between money supply and long term price levels in an economy. There are some disagreements on the applicability of the theory in the short run. Critics argue that velocity of money is not constant and also prices are sticky in the short run and therefore the strict direct relationship between money supply and price levels does not always hold. The mathematical calculations behind this theory are based upon fishers equation. This is calculated as $M * V = P * Q$ where M = money supply, V = velocity of money, P = price level and Q = volume of transactions in the economy. From the above equation, holding the transaction volume and velocity of money constant, any increases in the money supply will yield a proportional increase in the average price level.

In an economy like Ghana with new development of financial instruments and electronic transactions, the velocity of money is not likely to be constant. Also real output as established by the Ghana Statistical Service is not constant over time and therefore the assumption of constant velocity and output may not hold for the case of Ghana in the short run (considering the series of data used). This informs a priori expectation of a less than one positive coefficient for money supply in the model. This expectation can be confirmed by the work of Sanusi (2010), Bawumia and Abradu-Otoo (2003) and Adu and Marbour (2011).

- **Monetary policy rate**

Monetary policy is the process by which the monetary authorities of a country control the supply of money, often targeting a rate of interest for the purpose of promoting economic growth and

development (Federal Reserve Board, 2010). This is ultimately targeted at relatively stable prices and low unemployment rate.

Inflation targeting, the new monetary policy framework practically adopted by the BoG in 2002 but formally announced in 2007 uses monetary policy rate (prime rate) as its main tool of control with a targeted objective of stable prices. The prime rate is the rate at which commercial banks borrow from the central bank. The prime rate is expected to communicate the stance of monetary policy and act as a guide for all other market interest rates (CEPA, 2012). A monetary policy can be one of an expansionary or a contractionary policy. A rise in the prime rate, through the transmission mechanism, increases the market interest rate and this raises the lending rate of commercial banks leading to a fall in their supply of credit for households and firms. These results in less money in the economy, reduction in growth and the price level all due to a decrease in aggregate demand. This is an expansionary policy. A contractionary policy, on the other hand, is a direct opposite of an expansionary policy. A decision such as a reduction in the prime rate reduces the market interest rate increasing the supply of credit by the commercial banks. This leads to an increase in the money supply and aggregate output which results in high growth and higher price levels in the economy. Prime rate is therefore expected to have a negative relationship with inflation due to its usage in an inflation targeting regime. Our a priory expectation for prime rate will be a negative coefficient.

3.5 Econometric methods.

3.5.1 Unit root

Common characteristics of most economic and financial time series data has been their trending or nonstationary behaviours. Inclusion of such data renders a regression results spurious. This means that care needs to be taken to access the stationarity status of all included variables.

Although there are arguments in the literature which says the bounds cointegration test does not necessarily require the testing of series for their order of integration, there is also the need for the series to pass the very vital condition. All variables must be integrated to order zero (i.e I(0)) or one (i.e I(1)) or both in order to ensure the efficient operation of the ARDL model.

The time series properties of the data were analysed using the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) test. These two test for the presence of a unit root in the time series sample. The existence of a unit root implies the variable is nonstationary and the rejection of the existence of a unit root implies the variable is stationary. When dealing with larger and more complicated set of time series data, the augmented version of the dickey-fuller test, thus ADF is recommended. The Phillips-Perron (PP) unit root test developed by Phillips and Perron (1988) is also a build-up on the Dickey-Fuller test. This differs from the ADF test mainly in how serial correlation and heteroskedasticity in the errors are dealt with. Whilst the augmented Dickey-Fuller test addresses this issue by introducing lags of the dependent variable as regressors in the test equation, the Phillips-Perron test makes a non-parametric correction to the t-test statistic. Both the ADF and the PP statistic is a negative number and the more negative it is, the stronger the rejection of the null hypothesis, which states that there is a unit root, at some level of confidence.

The testing procedure for the ADF test is almost like that of the DF test but this is applied on the model. The model to be tested for unit root will be:

$$\Delta Z_t = \alpha + \beta t + \eta Z_{t-1} + \sum_{i=1}^p \phi_i \Delta Z_{t-i} + \varpi_t \quad (3.4)$$

where $Z_t = [\ln p^d_t, \ln m_t, \ln pr_t, \ln e_t, \ln p^f_t]$, where α is a constant, β the coefficient of a time trend and p the maximum lag order of the autoregressive process. The above equation is said to be a random walk with a trend and a drift. Imposing the constraints $\alpha = 0$ and $\beta = 0$ amounts to modelling a random walk while imposing $\beta = 0$ is modelling a random walk with a drift only.

Inclusion or exclusion of the intercept and/or time trend is very crucial to the results of the unit root test. Incongruous exclusion or inclusion of the intercept or deterministic time trend term results in a bias coefficient estimate for ϕ . Thus the actual size for the unit root test will be significantly different from the reported one.

The unit root test is carried out under the null hypothesis that $\eta = 0$ (not stationary and has a unit root) against the alternative hypothesis of $\eta < 0$ (stationary and has no unit root). The value for the test statistic $DF_\tau = \frac{\hat{\gamma}}{SE(\hat{\gamma})}$ is computed and compared to the relevant critical value for the Dickey-Fuller Test. If the absolute value of the test statistic is less (a smaller negative) than the critical value (a larger negative), the null hypothesis that $\eta = 0$ is not rejected, meaning there is a unit root present in the series. Thus the time series data is non stationary, otherwise the time series data will be said to be stationary.

The Phillips-Perron test, which follows almost the same procedure as the augmented dickey-fuller, is also used to confirm the stationary status of the data after the ADF has been used. In the case where a variable is found not to be stationary, the differencing method is used to attain stationarity but one should be wary of the fact that for the ARDL method to be applied no variable should be integrated to order two or more.

3.5.2 Cointegration approaches

There are several cointegration approaches in the literature to establish the long run relationship between cointegrating variables. Such frameworks includes that of Engle and Granger (1987), Johansen and Juselius (1990) and Gregory and Hansen (1996) etc. In these frameworks if two variables are integrated of the order one with its associated error term integrated to order zero, then those two variables can be said to be cointegrated. Meeting the strict requirement of an $I(1)$ creates some restrictions and difficulties with their application in determining cointegration between two or more variables. Another disadvantage in using these methods is the requirement of a larger sample size. Thus the methods work efficiently with large sample size therefore sample sizes such as 68 will not necessarily be appropriate for these methods of estimation.

The ARDL bounds testing approach to cointegration is therefore adopted to test for cointegration for this work. In an attempt to capture the long-run and short-run exchange rate pass-through to inflation, an error-correction model that follows the bounds testing methodology to cointegration by Pesaran et al (2001) is employed.

This method of estimation permits to test for cointegration whether the variables are $I(0)$ or $I(1)$ or a mixture of both (see Pesaran et al., 2001). It is not sensitive to small sample size, thus making it more efficient for small samples when compared to the other multivariate cointegration approaches. This method is also known to provide unbiased long run estimate regardless of the variables being endogenous or exogenous. Narayan (2005) and Odhianbo (2009) as cited in Amusa et al (2009) demonstrate that even when some of the independent variables are endogenous, the bounds testing approach generally provides unbiased long-run estimates and valid t-statistics. Also Pesaran and Shin (1999) concluded that modelling an ARDL with the right lag will correct for serial correlation and problems of endogeneity. This method

also allows the introduction of optimal lags of both the dependent and independent variables thereby allowing different variables to have their own optimal speed of adjustment to equilibrium. Last but not the least, OLS is easily employed to estimate the cointegration relationship.

With the bounds test, one is able to determine whether there is a long run relationship between two or more level variables with a joint significance test in the long run model. This method like any other method has its short falls, thus it is not appropriate for models with variables integrated to order two or more.

Following Pesaran et al (2001) as summarised in Frimpong and Oteng-Abayie (2006) and Sakyi (2011), we apply the bounds test procedure by modelling the general ARDL representation of conditional error correction model (ecm) base on equations 3.3a and 3.3b. This gives:

$$\begin{aligned} \Delta \ln p^d_t = & \alpha + \lambda_1 \ln p^d_{t-1} + \lambda_2 \ln m_{t-1} + \lambda_3 \ln pr_{t-1} + \lambda_4 \ln e_{t-1} + \lambda_5 \ln p^f_{t-1} + \sum_{i=1}^p \phi_i \Delta \ln p^d_{t-i} \\ & + \sum_{i=1}^p \phi_i \Delta \ln p^d_{t-i} + \sum_{i=0}^q \varphi_i \Delta \ln m_{t-i} + \sum_{i=0}^q \theta_i \Delta \ln pr_{t-i} + \sum_{i=1}^q \gamma_i \Delta \ln e_{t-i} + \sum_{i=0}^q \delta_i \Delta \ln p^f_{t-i} + \varepsilon_{t2} \end{aligned} \quad (3.5a)$$

$$\begin{aligned} \Delta \ln p^d_t = & \alpha + \lambda_1 \ln p^d_{t-1} + \lambda_2 \ln m_{t-1} + \lambda_3 \ln pr_{t-1} + \lambda_4 \ln e_{t-1} + \lambda_5 \ln p^f_{t-1} + \lambda_6 d \ln e_t \\ & + \sum_{i=1}^p \phi_i \Delta \ln p^d_{t-i} + \sum_{i=1}^p \phi_i \Delta \ln p^d_{t-i} + \sum_{i=0}^q \varphi_i \Delta \ln m_{t-i} + \sum_{i=0}^q \theta_i \Delta \ln pr_{t-i} + \sum_{i=1}^q \gamma_i \Delta \ln e_{t-i} \\ & + \sum_{i=0}^q \delta_i \Delta \ln p^f_{t-i} + \sum_{i=0}^q \eta_i \Delta d \ln e_{t-i} + \vartheta d_t + v_{t2} \end{aligned} \quad (3.5b)$$

where $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5$ and λ_6 are the long-run multipliers, $\phi_i, \varphi_i, \theta_i, \gamma_i, \delta_i$ and η_i define the short run multipliers, q and p are the order of lags, α is the drift and ε_{t2} and v_{t2} are the white noise error terms.

3.5.3 ARDL bounds testing procedure.

There are three steps involved in the ARDL bounds test procedure. The first step is to estimate equations (3.5a) and (3.5b) by ordinary least square (OLS) in order to test for the existence of a long run relationship amongst the variables.

Building of dynamic economic models most often entails detailed analysis of the characteristics of the individual time series variables involved (Lutkepohl and Kratzig, 2004). When these characteristics are ignored, and the set of series modelled jointly, the regression results obtained may exhibit a high level of correlation. Nonetheless, “the existence of a high degree of correlation between two variables does not automatically imply the existence of a causal relationship between the variables concerned” (Holden and Thomson, 1992). This correlation may be “spurious”. However, if two or more variables are cointegrated then the cointegration relationship among the variables rules out the possibility of the estimated relationship being “spurious” (Engle and Granger, 1987).

The cointegration property of the variables can be tested by conducting a joint F – statistics (or Wald statistics) of cointegration analysis. The joint significance of the coefficients of the lagged levels of the variables, ie $H_N: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$ against the alternative of $H_A: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq 0$ for equation (3.5a) and the nul hypothesis of $H_N: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0$ against the alternate hypothesis $H_A: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq 0$ for equation (3.5b). We then denote the test which normalizes for equation (3.3a) and (3.3b) respectively.

Two asymptotic critical values bounds provide a test for cointegration when the independent variables are $I(d)$ (where $0 \leq d \leq 1$), thus a lower value assuming the regressors are $I(0)$ and an

upper value assuming purely I(1) regressors. An F-statistic value above the upper critical F value implies the null hypothesis of no cointegration or no long run relationship can be rejected irrespective of the orders of integration for the time series. This implies there exist a long run relationship between the variables of interest. Conversely, if the test statistic falls below the lower critical value, the null hypothesis of no cointegration or no long run relationship cannot be rejected, meaning there exist no cointegration or no long run relationship between the variables of interest. Finally, if the statistic falls between the lower and upper critical values, the result is inconclusive.

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Once cointegration is established, we move on to the second step of estimating the conditional ARDL long run models $ARDL_1 (p_1, q_{11}, q_{12}, q_{13}, q_{14})$ and $ARDL_2 (p_2, q_{21}, q_{22}, q_{23}, q_{24}, q_{25},)$ for equations (3.5a) and (3.5b) respectively for p^d . The corresponding equation then becomes:

$$\ln p^d_t = \alpha + \sum_{i=1}^{p_1} \delta_i \ln p^d_{t-i} + \sum_{i=0}^{q_{11}} \delta_2 \ln m_{t-i} + \sum_{i=0}^{q_{12}} \delta_3 \ln pr_{t-i} + \sum_{i=0}^{q_{13}} \delta_4 \ln e_{t-i} + \sum_{i=0}^{q_{14}} \delta_5 \ln p^f_{t-i} + \varepsilon_{t3} \quad (3.6a)$$

$$\ln p^d_t = \alpha + \sum_{i=1}^{p_2} \delta_i \ln p^d_{t-i} + \sum_{i=0}^{q_{21}} \delta_2 \ln m_{t-i} + \sum_{i=0}^{q_{22}} \delta_3 \ln pr_{t-i} + \sum_{i=0}^{q_{23}} \delta_4 \ln e_{t-i} + \sum_{i=0}^{q_{24}} \delta_5 \ln p^f_{t-i} + \sum_{i=0}^{q_{25}} \delta_6 \ln e_{t-i} + \vartheta d_t + v_{t3} \quad (3.6b)$$

where all variables are as previously defined. The order of the ARDL models will be selected using the Schwarz Bayesian Criterion.

The third and final step involves the estimation of an equivalent error correction model associated with the long run estimates. This gives us the short run dynamic parameter in the model. This can be specified for model one and two as:

$$\Delta \ln p^d = \alpha + \sum_{i=1}^p \phi_i \Delta \ln p^d_{t-i} + \sum_{i=0}^q \varphi_i \Delta \ln m_{t-i} + \sum_{i=0}^q \theta_i \Delta \ln pr_{t-i} + \sum_{i=0}^q \gamma_i \Delta \ln e_{t-i} + \sum_{i=1}^p \delta_i \Delta \ln p^f_{t-i} + \Phi_{ecm_{t-1}} + \varepsilon_{t4} \quad (3.7)$$

$$\Delta \ln p^d = \alpha + \sum_{i=1}^p \phi_i \Delta \ln p^d_{t-i} + \sum_{i=0}^q \varphi_i \Delta \ln m_{t-i} + \sum_{i=0}^q \theta_i \Delta \ln pr_{t-i} + \sum_{i=0}^q \gamma_i \Delta \ln e_{t-i} + \sum_{i=1}^p \delta_i \Delta \ln p^f_{t-i} + \sum_{i=0}^q \eta_i \Delta \ln e_{t-i} + \beta d_t + \Phi_{ecm_{t-1}} + \nu_{t4} \quad (3.7b)$$

where $\phi_i, \varphi_i, \theta_i, \gamma_i, \delta_i$, and η_i are the short run dynamic coefficients of the model's convergence to equilibrium, and Φ is the speed of adjustment, thus the error correction term.

The statistical significance of all coefficients in all models is determined by comparing the probability value to the level of significance under consideration. If the probability value is less than the significant level then the null hypothesis of no significant effect of the independent variable on the dependent variable is rejected at that level of significance. This implies that the independent variable has a significant impact on the dependent variable and therefore the alternate hypothesis is valid. On the other hand if the probability value is greater than a significance level then the null hypothesis of no significant effect of the independent variable on the dependent variable is accepted at that level of significance. This implies that the independent variable under consideration has no significant effect on the dependent variable at the level of significance considered. The t-test will serve as a confirmation to the p-value testing procedure. When the calculated t-value of the respective variable is greater than the critical t-statistics as determined by the t-table, then the null hypothesis of no significant effect of that independent variable on the dependent variable will be rejected. On the other hand a t-value less than the

critical t-statistics will lead to the acceptance of the null hypothesis of no significant effect of that independent variable on the dependent variable.

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CHAPTER FOUR

ANALYSIS OF FINDINGS

4.1 Introduction

The results of the study are presented and discussed in this chapter. The chapter is divided into four sections. The first section examines the unit root properties of the variables used employing the Augmented Dickey-Fulley and Phillips-Perron unit roots test. The second section examines the long run relationship among all variables together in each model with the ARDL bounds approach to cointegration. The third Section presents and discusses the long run results of each of the three equations using the ARDL approach. The last Section presents and discusses the short run error correction model of each of the three equations along with its diagnostic test results.

4.2 Results of unit root.

Most often macroeconomic time series data contain unit roots that are characterized by the existence of stochastic trends as developed by Nelson-Plosser (1982). The stationarity of a time series must be examined because non stationary regressors produce spurious results and thus rejects empirical results. With the ARDL process, a unit root test is conducted to ensure none of the explanatory variables are integrated of order two $I(2)$ or more. Table 4.1 below presents the summary of the unit root test of the levels of all variables. At the level with a constant only, all variables considered were not significant for the ADF test. This implies that all variables had a unit root in their levels. These variables were not significant because the values of the t-statistics produced by the ADF test were less than the critical t-value of -2.908420 at the 5% significance level and -3.538362 at the 1% significance level.

Table 4.1 Results of unit root test – Level variables

Variables	Augmented Dickey-Fuller		Phillips-Perron	
	Constant	Constant + trend	Constant	Constant + trend
$\ln p^d$	-1.548 (0.503)	-0.455 (0.983)	-4.244*** (0.001)	-2.754052 (0.219)
$\ln m$	-0.124 (0.9416)	-3.641064** (0.0342)	-0.687930 (0.842)	-3.851158** (0.0197)
$\ln pr$	-0.830 (0.8039)	-2.606049 (0.2792)	-0.644470 (0.8528)	-2.310663 (0.4224)
$\ln e$	-1.765 (0.394)	-2.186610 (0.489)	-2.249103 (0.1914)	-1.558539 (0.7988)
$\ln p^f$	-0.560 (0.8717)	-3.540027** (0.0432)	-0.734345 (0.829)	-3.513005** (0.0463)

Note: *, **, *** denotes the rejection of the null hypothesis of a unit root at the 10%, 5% and 1% significance level respectively. Results were obtained from the Eviews 7.1 econometric package software

This implies the null hypothesis of unit root cannot be rejected and therefore the variables are integrated to a higher order. After adding a trend, money supply with a t-statistic of -3.641064 and foreign inflation also with a t-statistic of -3.540027 were significant at the 5% level since the values of their t-statistics were greater than the critical values of -2.908420 at the 5% significance level. This implies that the null hypothesis of unit root was not rejected for, $\ln p^d$, $\ln e$ and $\ln pr$ whiles it was rejected for $\ln m$ and $\ln p^f$ inflation with a constant and trend. With the exception of $\ln p^d$ with a constant only where the ADF accepted the null hypothesis of unit root whiles the PP test rejected the null hypothesis at a 1% significance level, all other results were confirmed by the Phillips-Perron test by producing almost equal results as the ADF test.

Table 4.2 Stationarity results after first differencing.

Variables	Augmented Dickey-Fuller		Phillips-Perron	
	Constant	Constant + trend	Constant	Constant + trend
p^d	-3.770*** (0.005)	-3.480** (0.0507)	-6.513*** (0.000)	-11.102*** (0.000)
m	-3.715*** (0.0061)	-3.645** (0.0341)	-16.943*** (0.000)	-20.500*** (0.000)
pr	-5.124*** (0.0001)	-5.084*** (0.0005)	-5.139*** (0.0001)	-5.101*** (0.0005)
e	-4.018*** (0.002)	-4.242*** (0.007)	-3.274** (0.0201)	-3.525** (0.0448)
p^f	-8.382*** (0.0000)	-8.319*** (0.0000)	-18.310*** (0.0000)	-18.974*** (0.0001)

Note: *, **, *** denotes the rejection of the null hypothesis of the unit root test at the 10%, 5% and 1% significance level respectively. Results were obtained from the Eviews 7.1 econometric software

In Table 4.2, the first difference of all variables under consideration were taken and the results of both the ADF and the PP unit root test confirmed the rejection of a unit root at 5% significance level for all variables with majority attaining stationarity at the 1% significance level. This was because the absolute values of the test statistic of each variable from the ADF were greater than the absolute critical values of -2.908(with a constant only) and -3.48 (with a constant and linear trend) at the 5% and 1% significance levels respectively. This is an indication that one can proceed to use the ARDL bounds test approach since none of the variables were found to be integrated to the order two or more.

4.3 Results of ARDL bounds test for cointegration.

The next step is to investigate whether there is a long run relationship between the variables of interest. To achieve this in the ARDL framework, the presence of long run relationship in equations (3.4a), and (3.4b) were tested. The Schwarz Bayesian criterion was used with a maximum lag order of 3 for the conditional ARDL-VECM. As in Pesaran et al (2001), OLS regressions for equation (3.4a) and (3.4b) were estimated and the joint significance of the parameters of the lagged level variables when added to the first regression was tested. The OLS regression itself according to Pesaran et al (2001) “is of no direct interest” to the bounds cointegration test. The F-statistics is used to test the joint hypothesis that the coefficients of the lagged level variables are zero (no cointegration) or otherwise. Table 4.3 shows the cointegration results for the three equations.

Table 4.3 Cointegration results

Model	No of Regressors	F-statistics	Lower – Upper bound	Outcome
I	4	8.2102**	3.0696 - 4.2981	Cointegrated
II	6	5.5424**	2.819 - 4.1175	Cointegrated

Note: *, **, *** denotes the rejection of the null hypothesis of no cointegration at the 10%, 5% and 1% significance level respectively. Results were obtained from Mirofit 5.0 econometric software

From Table 4.3, all two models were found to be cointegrated, thus all variables considered have some long run relationship. In model one, the f-statistic of 8.1598 was found to be greater than the upper bound critical value of 4.2981. According to Pesaran et al (2001) the null hypothesis of no cointegration should be rejected. One can therefore conclude with such results that model one is cointegrated. Model two also had an F-statistic value of 5.542 with an upper bound value of 4.117. The null hypothesis of no cointegration has been rejected per the results obtained. Clearly

after the addition of the dummy variable and the interaction term the equation still remained cointegrated. This means the addition the dummy variable and an interaction (multiplication term) between the dummy variable and the exchange rate did not distort the cointegration property of model one. The establishment of a long run relationship is very necessary to the procedure of estimation, thus the ARDL methodology. Since all models are cointegrated, we precede to the results of the ARDL model.

4.4 Results of ARDL estimation.

Once cointegration is established, we proceed to estimate the ARDL model with a specification of ARDL (1,3,0,0,0) for model one and ARDL (1,3,0,0,0) for model two. The lag selection criterion adopted for this estimation was the Schwarz Bayesian criterion. Table 4.4 presents the results of the long run estimation of the ARDL for the two models.

Results of the estimated long run coefficients for model I and II are presented in Table 4.4. With the exception of prime rate in model II, all other coefficients were found to be bearing their expected signs. Money supply which happens to be one of the major contributors to inflation in Ghana had a positive and significant coefficient in both models. This confirms the quantity theory of money that an increase in money supply ends up increasing the nominal prices of goods and services. The coefficient of approximately 0.24 for model one represents elasticity of price level with respect to money supply and it implies a 1% increase in the money supply will results in a 0.24% increase in the price level. This means an increase in the money supply has the potential to significantly increase the price level in the long run. These values when compared with that of Bawumia and Abradu-Otoo (2003) result of 0.41, money supply coefficient can be said to be a reduction in the impact of money supply on price level.

Table 4.4 Results of the long run ARDL estimation for models I and II

Variable	Model I		Model II	
	Coefficient	T-ratio	Coefficient	T-ratio
$\ln m$	0.236	1.699*	.30859	3.4356***
$\ln pr$	-0.061	-0.542	.063470	.77518
$\ln e$	0.291	4.445***	.25266	5.7321***
$\ln p^f$	1.741	1.124	1.5895	1.5519
$d \ln e$	--	--	-.19857	-3.4778***
d	--	--	-.086470	-3.4263***
c	5.742	0.7864	5.9192	1.2150

Note: *, **, *** denotes the rejection of the null hypothesis of no long run relationship at the 10%, 5% and 1% significance level respectively. Results were obtained from the Microfit 5.0 econometric software

Other empirical works such as Adu and Marbuah (2011), Sowa and Kwakye (1993) and Attah-Mensah and Bawumia (2003) all confirmed to the positive significant coefficient for money supply in thier studies. Ocran (2007) however, arrived at a weird conclusion that excess money supply does not determine long run inflation as oppose to the numerous literature for Ghana. This result therefore shows that the historic nexus between money supply and inflation for Ghana still exist in an appreciable magnitude.

The coefficient of prime rate in model I was negative but insignificant. The negative sign was in line with initial expectations. The coefficient of -0.06 implies a 1% increase in the prime rate is expected to have a 0.061 negative impact on the price level. That is an increase in the prime rate is expected to raise general interest rate leading to a reduction in the money supply and finally a reduction in the price level. Other works such as Frimpong and Adam (2010) and Adu and

Marbour (2011) using short term interest rate to represent the behaviour of the central bank of Ghana found a positive significant relationship between interest rate and inflation. It is well noting that the sample of these works was bias towards periods when IT was not the main monetary policy tool used. The negative but insignificant results clearly hint the role of the prime rate in the reduction of inflation as used by most central banks in the world today practicing inflation targeting.

The coefficient of exchange rate, the variable of keen interest, was also positive and significant at the 1% significance level. The positive sign confirms the purchasing power parity rule which seek to imply that an increase in the domestic price of a foreign currency leads to an increase in the import price of all goods imported and finally increases the domestic price level of the domestic economy. With an elasticity coefficient of 0.29, a 1% increase in the domestic price of a foreign currency will results in approximately 0.29% increase in the domestic price level. This implies there is a 29% pass-through from exchange rate to inflation. This finding is in line with the work of Bawumia and Abradu-Otoo (2003) who also arrived at a long run pass-through of 29%, Acheampong (2005) who arrived at a 24% pass-through and Sausa (2010) who arrived at a 71% pass-through. This implies the long run pass-through has most often remained large and positive. On the other hand, this result contradicts that of Frimpong and Adam (2010) who concluded that there is a low and insignificant pass-through from exchange rate to inflation in the long run. This finding clearly explains the high inflationary experience in 2000 and 2008 mainly attributed to the fast and high exchange rate depreciation in these periods. Adu and Marbour (2012) also attributed their negative and significant exchange rate nexus to exchange rate scarcity in the 1970's resulting in substantial transactions occurring in the parallel exchange rate market and supported their results with similar findings by Ndung'u (1997) for Kenya. Since our

sample period contained no observation in the 1970's a negative pass-through is not expected in this study.

Foreign inflation also had a larger and positive but statistically insignificant coefficient. The positive sign is in line with the purchasing power parity rule that an increase in the foreign price of a commodity will lead to an increase in the domestic price of that commodity all other things being equal. The 1.74 elasticity coefficient indicates that a 1% increase in the foreign price of a commodity will result in a 1.7% increase in the price level but this was insignificant at all levels of significance considered in this study. This contradicted the negative significant results of Frimpong (2010) and the positive long run coefficient of Ocran (2007).

The results of model II were not very different from that of model I in that the coefficient of the variables in model one went through very small changes when compared to that of model two. All coefficients with the exception of prime rate maintained their signs. Money supply which had an elasticity coefficient of 0.24 assumed an elasticity coefficient of approximately 0.31, a difference of 0.067 approximately and was significant at the 1% significance level. Prime rate which had an elasticity coefficient of -0.061 in model I was found to be 0.064 in model II and still not significant as that of model I. Exchange rate assumed an elasticity coefficient of 0.25 which was almost similar to that of model one, 0.29, and was still significant at the 1% significance level. The coefficient of foreign inflation was recorded to be approximately 1.60, a reduction when compared to that of model I but was still not significant at all levels of significance considered in this work.

The most important variables for consideration in model II are the dummy variable indicating the periods before and after inflation targeting and the interaction term between the dummy variable

and the exchange rate. The dummy variable was with a coefficient of -0.086 and significant at the 1% significance level. This shows that the introduction of inflation targeting policy has reduced the general inflation levels by 0.086%. This is consistent with the Taylor's hypothesis that the adoption of inflation targeting policy leads to a lower inflationary environment. The results also confirm the assertion of Opoku-Afari (2005) that the adoption of an *inflation targeting lite* framework has reduced the level of inflation in Ghana.

The interaction between the dummy variable and exchange rate represents the impact of inflation targeting on the pass-through from exchange rate to inflation. This was negative as expected and also highly significant. The long run coefficient of -0.19857 indicates that the introduction of inflation targeting has reduced the pass-through from exchange rate to inflation by 19.85%. This implies that the extent to which exchange rate depreciation and appreciation influences inflation has drastically reduced after the adoption of the IT policy in Ghana. It must be noted that the sample periods after inflation targeting was considered had relatively lower inflationary environment. This strongly supports Taylor's hypothesis of a lower pass-through in a lower inflationary environment. Also it falls in line with the conclusion of a lower pass-through in a lower inflationary environment from 2001 to 2003 by Acheampong (2005)

4.5 Results for short run error correction model

The short run coefficients reports shocks in the long run due to deviations from the long run equilibrium. The short run equilibrium therefore shows the dynamic adjustment of all variables to their long run equilibrium

Table 4.5 Estimated short run error correction model for model I and II

Variable	Model I		Model II	
	Coefficient	t-ratio	Coefficient	t-ratio
$\Delta \ln m$	-0.038	-0.681	-0.044	-0.830
$\Delta \ln pr$	-0.011	-0.536	0.016	0.777
$\Delta \ln e$	0.056	2.956***	0.065	3.835***
$\Delta \ln p^f$	0.314	1.189	0.416	1.629
$\Delta d \ln e$	---	---	-0.051	-3.191***
Δd	---	---	-.022	-3.160***
Δc	1.037	0.822	-1.529	1.267
$ecm(-1)$	-0.181	-3.967***	-0.258	-5.270***
R-Bar-Squared 0.65987		R-Bar-Squared 0.70422		
S.E. of Regression 0.024709		S.E. of Regression 0.023042		
F-Stat. F(7,60) 19.7121[.000]		F-Stat. F(9, 58) 18.8359[.000]		
DW-statistic 1.7003		DW-statistic 1.9234		
Note: *, **, *** denotes the rejection of the null hypothesis at the 10%, 5% and 1% significance level respectively. Results were obtained from the microfit 5.0 econometric software				

Table 4.6 presents the results of the short run error correction model for models I and II. The signs of the coefficients of the variables in both models were not different from that of their respective long run models with the exception of money supply which had a negative sign as opposed to a positive long run coefficient.

From model I, the short run coefficient of money supply was -0.038 which signifies a negative elasticity of price level with respect to a shock in the money supply in the short run. This was insignificant at all considered levels and can be interpreted to mean money supply has an insignificant effect on the price level in the short run. This implies money supply have low or no effect on price level in the short run but have a positive and significant effect on price level in the

long run. This was not different from the results of Bawumia and Abradu-Otoo (2003) that the effect of money on price level have a 2 months delay. Sanusi (2010) also concludes an elasticity of 0.089 for money supply and also contradicted the 0.61 significant short run elasticity arrived at by Adu and Marbour (2011).

Prime rate maintained a negative and insignificant coefficient in the short run just as in the long run for model I. The insignificant elasticity coefficient of approximately -0.011 implies a 1% increase in the prime rate results in a 0.01099 reduction in the price level but this as mentioned earlier is insignificant per all significance levels considered. This is because prime rate is the tool used to mop up excess money supply in the economy to ensure stability in the form of reduction in inflation. Thus the increase in the prime rate leads to an increase in the general interest rate and this attracts investors to channel their funds into interest yielding assets and thereby reducing the liquidity in the economy leading to a reduction in the price level. Monetary policy rate is therefor expected to have a negative effect on money supply and finally on price levels. This was inconsistent with the results of Adu and Marbour (2011) for reasons explained earlier.

Exchange rate which happens to be the variable of interest maintained a positive and highly significant coefficient called the exchange rate pass-through. The short run elasticity coefficient of approximately 0.053 implies a 1% increase in the exchange rate leads to 0.053% increase in the price level in the short run. This implies that exchange rate depreciation has a positive impact on the price level and this can be explained by the purchasing power parity rule. When compared to the long run coefficient of 0.267 one can deduce that the exchange rate has a larger impact on inflation in the long run than in the short run and this is in line with works such as Bawumia and Abradu-Otoo (2003), and Sasuni (2010).

Foreign inflation had an elasticity coefficient of 0.314 but was insignificant at the levels of significance considered. The positive short run coefficient implies that a 1% increase in foreign inflation will result in a 0.314% increase in the domestic price level. The positive sign is consistent with theory and the long run results.

The error correction term (etc.) measures the speed of adjustment to restore equilibrium in the long run after a shock in the model. The equilibrium correction coefficient of -0.1805 is significant at 1% and has the correct sign. This indicates a moderate speed of adjustment to equilibrium after a shock. Approximately 18% of disequilibria from the previous quarters' shock converge back to the long-run equilibrium in the current quarter. This means it will take almost 5 quarters for the impact of exchange rate on price level to fully reflect in the economy. This According to Verma (2007) indicates a proof of the existence of a stable long run relationship in the model.

The short run ARDL results for model II is also presented in Table 4.1 above. Money supply maintained a negative but insignificant short run coefficient of -.044. This, as said earlier, indicates money supply in the very short run has very less or no effect on the price level. Prime rate recorded a positive but insignificant short run coefficient of 0.016 as oppose to the negative but insignificant short run coefficient of -0.011 in model I. This is consistent with the long run coefficient for model II with respect to the sign. Exchange rate also recorded an elasticity short run coefficient of 0.065 which is consistent to all similar coefficients in all estimations with respect to their sign.

The variables of interest in this model are the dummy variable and its interaction with the exchange rate to ascertain the impact of the adoption of inflation targeting policy on the pass-

through from exchange rate to prices. The dummy variable representing the periods after the adoption of inflation targeting policy had a negative and significant value of -0.022. This implies the adoption of inflation targeting policy has succeeded in reducing the general price level by 0.022 in the short run. The interaction between the dummy variable and the exchange rate had a negative short run elasticity coefficient of -0.051 and this implies a reduction in the impact of exchange rate on inflation in the short run by 0.051 after the introduction of the inflation targeting policy. This strongly confirms the hypothesis of Taylor (2000) concerning exchange rate pass-through and inflation targeting.

The equilibrium correction coefficient of -0.25 is significant and has the correct sign. This indicates a moderate speed of adjustment to the long run equilibrium after a shock in the short run. Approximately 25% of disequilibria from the previous quarters' shock converge back to the long-run equilibrium in the current quarter. This means it will take almost 4 quarters for the impact of exchange rate on price level to fully reflect in the economy in model II.

The adjusted R^2 for model I and II were 0.66 and 0.70 respectively. This shows the percentage of the variation in the independent variables explained by variations in all the dependent variables combined after some adjustments. The CUSUM and CUSUMQ test for model I in the Appendix (Fig. A1) indicates stability at the 5% significant level. This indicates a well structured and stable model. The CUSUM and CUSUMQ test for model II in the Appendix (Fig. A2) however showed slight instability at the 5% significance level but was stable at the 10% significance level.

4.6 Conclusion

The results indicated that money supply and exchange rate are the major factors that influence inflation in the long run. This confirms the assertion by Bawumia and Abradu-Otoo (2003) that

inflation in Ghana is a monetary phenomenon. The pass through from exchange rate to price levels was positive and significant but incomplete. The dummy for the policy inflation targeting had a negative coefficient, an indication that inflation targeting have succeeded in reducing average inflation in Ghana. The interaction between the dummy variable and the exchange rate variable also had a negative sign. This is an indication that exchange rate pass through after the adoption of inflation targeting has reduced. One can therefore conclude that IT has achieved its intended purpose, especially when statistics shows that average economic growth for 2002-2012 was 7.04% while that of 1995-2001 was 4.27%.



CHAPTER FIVE

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

This chapter provides a general summary of findings from the study and its implications on policies and the economy as a whole. The chapter also provides policy recommendations based on results obtained and closes with a general conclusion of the study.

5.2 Summary of findings

The study assessed the impact of inflation targeting policy framework on domestic inflation and the nature of exchange rate pass-through to inflation after the adoption of IT policy in Ghana. Using the ARDL bounds testing approach to cointegration and the error correction model, the study estimated the long run and short run relationship between inflation and exchange rate for the periods 1995Q1 to 2011Q4. A model containing a dummy variable to capture the period after the introduction of IT (i.e. 2002Q2) and an interaction term between exchange rate and the dummy variable was estimated to investigate the impact of IT on domestic inflation and exchange rate pass-through. The findings of the study are as follows:

The study revealed a significant long run relationship for inflation and money supply in all three models. In model I, the long run elasticity coefficient for money supply was approximately 0.24 and this implies a 1% increase in money supply will result in a 0.24% rise in the price level in the long run and vice versa. Model II recorded a significant elasticity coefficient 0.31 for money supply. All results obtained in the short run model were negative but statistically insignificant. These results confirm the quantity theory of money and therefore show that money supply plays a very significant role in the determination of inflation in Ghana. The short run results also

supports the argument of the critics of the quantity theory of money that price is sticky and that money only affects prices with time.

The prime rate was not consistent with respect to the sign and expectation of the study. The long run elasticity coefficients were -0.0609 and 0.0634 for models I and II respectively. All the long run coefficients together with their short run coefficients were insignificant for prime rate. Interestingly the tool expected to control inflation had very little impact on inflation both in the long and short run and this brings into question the BoG's full commitment to the inflation targeting framework, thus the use of prime rate as the main tool for manipulating inflation. This weak relation can be attributed to the indirect use of prime rate in controlling inflation. Thus prime rate works through market interest rate and money supply to impact on inflation therefore prime rate has no direct impact on inflation unlike money supply and exchange rate. The resistance of the market interest rate in response to the prime rate due to inflation expectations and future prime rates can also not be overlooked.

Exchange rate, the variable of interest, was found to be significant in both the long run and short run for all two models. In the long run, a rise in the exchange rate by 1% is expected to raise prices by 0.29% and 0.25% in model I and II respectively. The short run results of 0.05 and 0.065 were all significant at the 1% significance level and also matched expectations. This shows that the direct and indirect influence of exchange rate through importation of finished and primary goods for local consumption and production still remains significant in the determination of inflation in Ghana. Exchange rate remains a significant contributor to inflation per the sample period considered and therefore confirms the purchasing power parity rule.

The study also confirmed a lower inflationary environment which can be attributed to the adoption of inflation targeting policy. The dummy variable in model II assumed a coefficient of -0.086. The negative dummy coefficient implies that there has been a reduction in the average inflation after the introduction of the IT policy. This gives a general impression of a negative impact of the introduction of inflation targeting on domestic price level. Consistent with the Taylor's hypothesis, the coefficient of the interaction between exchange rate and the dummy variable was negative and significant in model II. The negative and significant elasticity coefficient of -0.1985 indicates a reduction of pass-through from exchange rate to price levels by 19.85% after the introduction of the IT policy and this can be said to be a very huge reduction. The result suggest that a chunk of the reduction of inflation due to the introduction of the IT policy can be attributed to the reduction of exchange rate pass-through and this was strongly in line with expectations.

Foreign consumer price index had a large long run coefficient of 1.741 and 1.59 in model I and II respectively. These were however insignificant at all the conventional error level. The resulting short run coefficient followed the same trend of large coefficient but statistically insignificant at all conventional error level. The positive sign shows that foreign prices have some positive relationship with our domestic prices and therefore was consistent with the purchasing power parity rule.

5.4 Conclusion

This study sought to find out if inflation targeting has helped reduce inflation and the pass-through from exchange rate to inflation with the help of the purchasing power parity rule. With a quarterly data from 1995 to 2011, the study used the ARDL bounds testing approach to

cointegration to establish the long run and short run effects of exchange rate and inflation targeting policy on inflation in Ghana.

The Augmented Dickey-Fuller and the Phillips-Perron unit root tests were used to investigate the stationarity properties of the variables prior to estimation to ensure that no variable is integrated of order two. Most variables were not stationary at the levels but all variables attained stationarity after first differencing. The Bounds cointegration approach was used to establish cointegration amongst the variables.

The results suggested that money supply and exchange rate are the main drivers of inflation in the long run. Even though prime rate and foreign inflation appeared not to be significant, they were bearing their expected signs of negative and positive respectively. In the short run exchange rate was the only significant contributor to high inflation in Ghana. The results clearly suggest that inflation in Ghana is a pure monetary phenomenon. The introduction of the IT policy significantly led to a reduction in the average inflation both in the long run and short run. This suggests that IT to an extent has been successful in tackling inflation in Ghana. The interaction between exchange rate and the dummy variable was also found to have a statistically significant negative impact on inflation. This implies that the IT policy has been very successful in reducing the pass-through from exchange rate to inflation drastically and therefore is an appropriate policy to tackle exchange rate pass-through in Ghana.

5.3 Recommendations

The issue of high inflation and the search for a credible policy to halt these high levels of inflation has been a big problem for the monetary authorities of Ghana. Such a policy is expected to reduce the impact of the prominent causes of inflation; be it money supply or/and exchange

rate as empirically established in Ghana. The empirical results arrived at informs some strong policy implications. Recommendations have been provided to help improve the new policy adopted by the central bank of Ghana.

The results showed that money supply remains a significant contributor to inflation only in the long run. The results suggested that the inflationary effect of monetary expansion cannot be overlooked therefore controlling monetary expansion will be a key remedy to the inflationary pressures experienced in Ghana. Policies to control the monetary expansion should be instituted to ensure a reduction in the rate of change in prices. The study therefore agrees with Adu and Marbour (2011) that controlling monetary expansion can be used as an intermediate target variable in the conduct of monetary policy in Ghana.

Prime rate, the main tool of control under an inflation targeting policy framework had an insignificant effect on inflation. This implies that the official prime rate had very little or no relationship with inflation. This can be explained by the use of prime rate as an indirect control since it works through market interest rate and the money supply. Also the bottlenecks in the interest rate pass-through from prime rate to market interest rate inhibit a fast transmission from prime rate to market interest rate. The Central Bank's inability to anchor inflation expectations and a relatively high treasury bill rate competing with private interest rates makes it difficult for the market interest rate to respond to the monetary policy rate sharply. A cap on government domestic borrowing to ensure a low treasury bill rate and a long maintenance of a single digit inflation to effectively anchor inflation expectation will serve as a solution to clear these bottlenecks to ensure fast transmission and proper functioning of the prime rate. Exchange rate pass-through, the issue of interest, in this study was positive and significant both in the long and short run. This signifies the important role of exchange rate in the inflationary process in Ghana

even though there has been significant reduction in the pass-through when compared to other works. The initiation of a public-private partnership to encourage the production of imported goods (import substitution firms) will help reduce foreign exchange demand and its depreciatory pressures on our domestic currency. This will end up slowing the rate of depreciation leading to lower inflationary pressures.

The negative dummy coefficient suggest that the introduction of inflation targeting policy have reduced long run average inflation in Ghana by 8.64% and that of the short run by 2.2%. This implies that the IT policy has succeeded in reducing inflation as expected but there has been frequent missing of inflation targets. Clearing of the bottlenecks in interest rate pass-through to market interest rate and movement from an *inflation targeting lite* practice to a full fledged inflation targeting policy will be of great help in the effort towards low and stable inflationary environment. The interaction between exchange rate and the dummy variable indicating the period before and after the introduction of the IT policy was negative and significant in the long and short run. This implies that the IT policy has succeeded in reducing the pass-through from exchange rate to inflation and therefore confirms the Taylor's hypothesis that adoption of inflation targeting will lead to a lower pass-through. This implies further strengthening of IT as our main monetary policy will be very helpful in the goal towards achieving a stable and single digit inflation rate.

Foreign inflation had a positive but statistically insignificant influence on prices. Since this is out of the control of our monetary authorities a correct inclusion of foreign inflation in our price level prediction will ensure much accuracy in our prediction of inflation under an IT regime to help in the anchoring of inflation expectations.

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APPENDIX

Table A1: Long Run Results for Model I.

Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,3,0,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is LNCPI
68 observations used for estimation from 1995Q1 to 2011Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LNM	.23567	.13873	1.6987[.095]
LNMPR	-.060913	.11247	-.54161[.590]
LNEX	.29077	.065415	4.4450[.000]
LNFCPI	1.7413	1.5494	1.1238[.266]
C	5.7421	7.3016	.78642[.435]

Table A2: Short Run Error Correction Model for Model I.

Error Correction Representation for the Selected ARDL Model
ARDL(1,3,0,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is dLNCPI
68 observations used for estimation from 1995Q1 to 2011Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dLNM	-.038350	.056356	-.68050[.499]
dLNM1	.22471	.069640	3.2268[.002]
dLNM2	.26151	.058961	4.4353[.000]
dLNMPR	-.010999	.020506	-.53637[.594]
dLNEX	.052504	.017761	2.9561[.004]
dLNFCPI	.31442	.26441	1.1891[.239]
ecm(-1)	-.18057	.045515	-3.9672[.000]

List of additional temporary variables created:

dLNCPI = LNCPI-LNCPI(-1)
dLNM = LNM-LNM(-1)
dLNM1 = LNM(-1)-LNM(-2)
dLNM2 = LNM(-2)-LNM(-3)
dLNMPR = LNMPR-LNMPR(-1)
dLNEX = LNEX-LNEX(-1)
dLNFCPI = LNFCPI-LNFCPI(-1)
ecm = LNCPI -.23567*LNM + .060913*LNMPR -.29077*LNEX -1.7413*LNFCPI -
5.7421*C

R-Squared	.70048	R-Bar-Squared	.65987
S.E. of Regression	.024709	F-stat.	F(7, 60 19.7121[.000]
Mean of Dependent Variable	.047462	S.D. of Dependent Variable	.042368
Residual Sum of Squares	.036023	Equation Log-likelihood	159.9778
Akaike Info. Criterion	150.9778	Schwarz Bayesian Criterion	140.9900
DW-statistic	1.7003		

R-Squared and R-Bar-Squared measures refer to the dependent variable dLNCPI and in cases where the error correction model is highly restricted, these measures could become negative.

Table A3: Cointegration results for model I.

Testing for existence of a level relationship among the variables in the ARDL model

F-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
8.2102	3.0696	4.2981	2.5808	3.6975

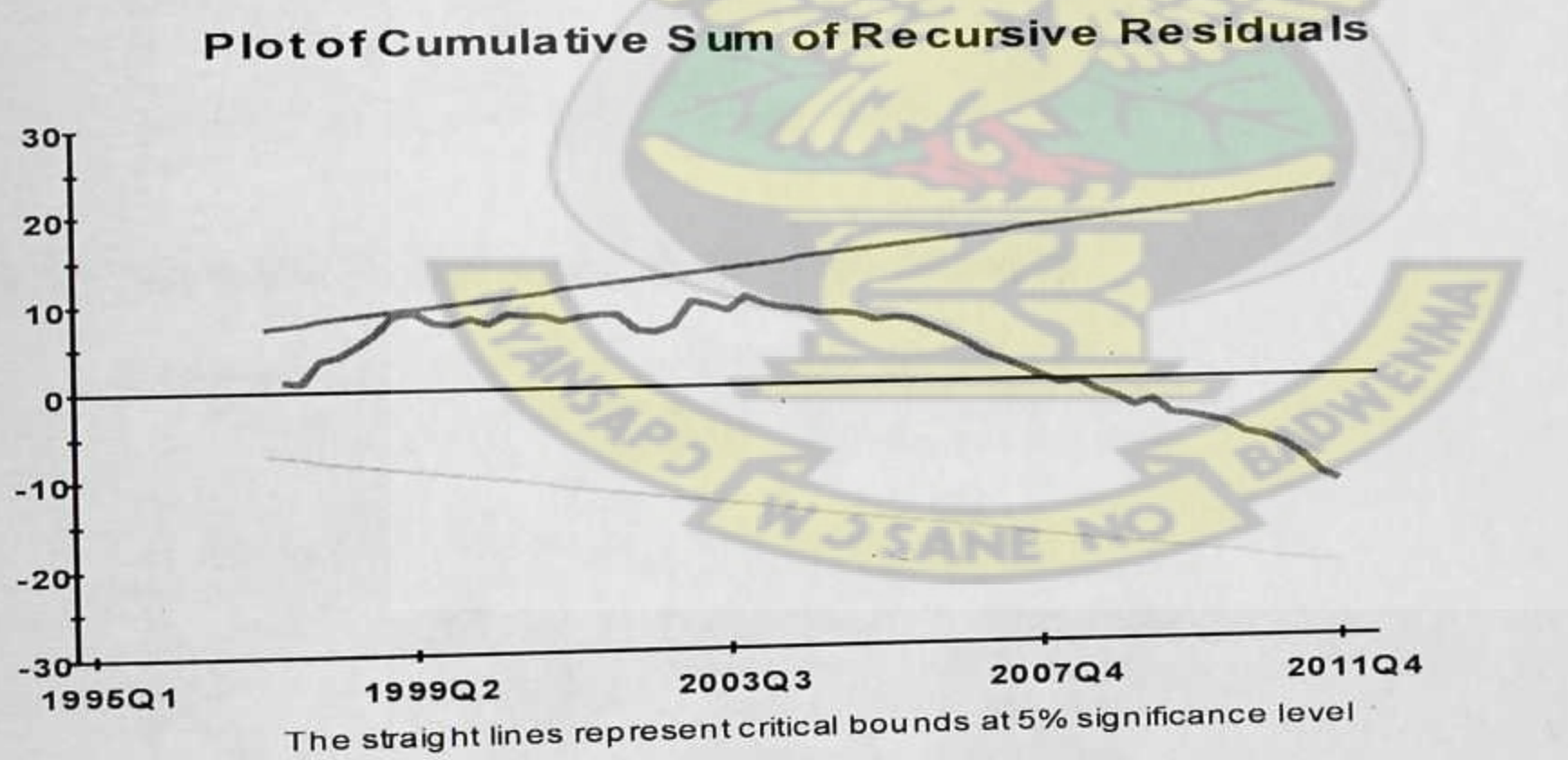
W-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
41.0508	15.3479	21.4904	12.9038	18.4877

Table A4: Diagnostics

Diagnostic Tests

* Test Statistics	* LM Version	* F Version	*
* A:Serial Correlation	* CHSQ(4) = 4.3094[.366]	*F(4,55) = .93035[.453]	*
* B:Functional Form	* CHSQ(1) = .19469[.659]	*F(1,58) = .16654[.685]	*
* C:Normality	* CHSQ(2) = 4.3036[.116]	* Not applicable	*
* D:Heteroscedasticity	* CHSQ(1) = 1.1487[.284]	*F(1,66) = 1.1341[.291]	*

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values



Plot of Cumulative Sum of Squares of Recursive Residuals

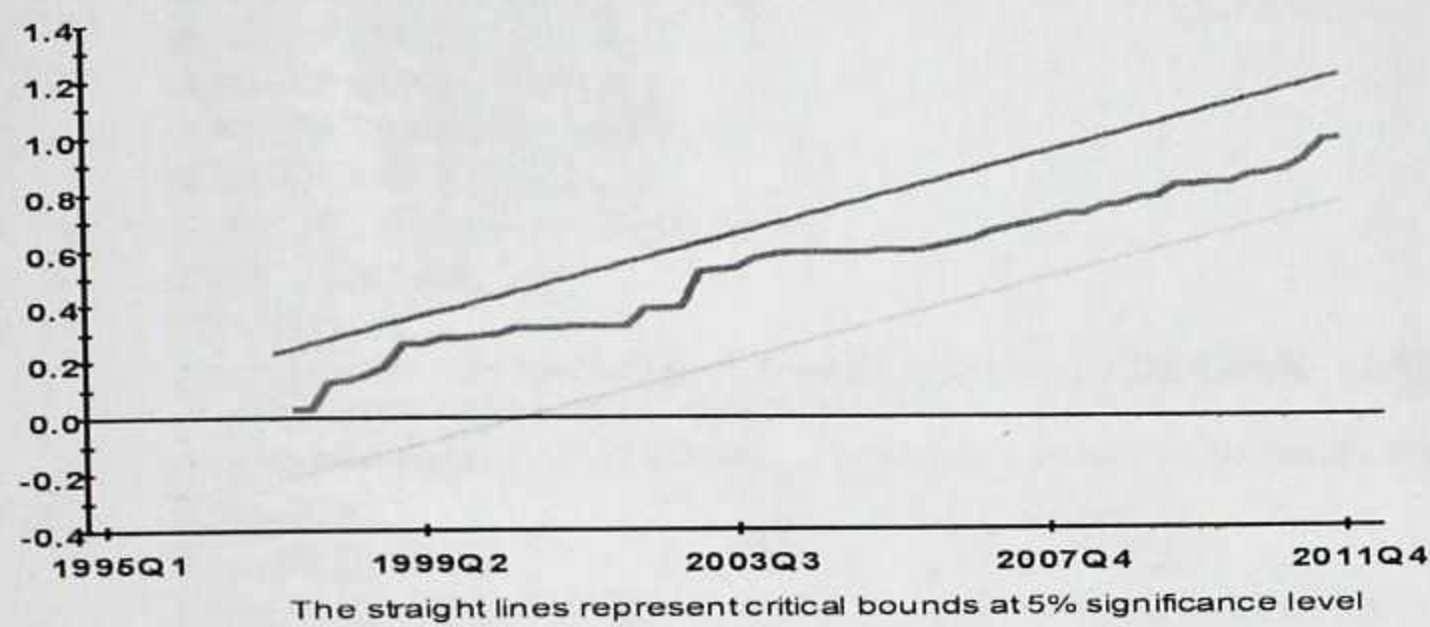


Figure A1: CUSUM and CUSUMQ test for parameter consistency.

Table A5: Long Run Results for Model II.

Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,3,0,0,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is LNCPI
68 observations used for estimation from 1995Q1 to 2011Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LNM	.30859	.089822	3.4356[.001]
LNMPR	.063470	.081878	.77518[.441]
LNEX	.25266	.044077	5.7321[.000]
LNFCPI	1.5895	1.0242	1.5519[.126]
DEX	-.19857	.057096	-3.4778[.001]
D	.086470	.025237	3.4263[.001]
C	5.9192	4.8719	1.2150[.229]

Table A6: Short Run Error Correction Model for Model II.

Error Correction Representation for the Selected ARDL Model
ARDL(1,3,0,0,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is dLNCPI
68 observations used for estimation from 1995Q1 to 2011Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dLNM	-.043846	.052813	-.83021[.410]
dLNM1	.16132	.068147	2.3672[.021]
dLNM2	.22520	.056243	4.0040[.000]
dLNMPR	.016394	.021107	.77672[.440]
dLNEX	.065262	.017018	3.8348[.000]
dLNFCPI	.41057	.25210	1.6286[.109]
dDEX	-.051291	.016075	-3.1908[.002]
dD	.022336	.0070681	3.1601[.003]
ecm(-1)	-.25830	.049007	-5.2707[.000]

List of additional temporary variables created:

dLNCPI = LNCPI-LNCPI(-1)
dLNM = LNM-LNM(-1)
dLNM1 = LNM(-1)-LNM(-2)
dLNM2 = LNM(-2)-LNM(-3)
dLNMPR = LNMPR-LNMPR(-1)
dLNEX = LNEX-LNEX(-1)
dLNFCPI = LNFCPI-LNFCPI(-1)
dDEX = DEX-DEX(-1)
dD = D-D(-1)
ecm = LNCPI -.30859*LNM -.063470*LNMPR -.25266*LNEX -1.5895*LNFCPI +
.19857*DEX -.086470*D - 5.9192*C

R-Squared	.74837	R-Bar-Squared	.70422
S.E. of Regression	.023042	F-Stat. F(9,58)	18.8359[.000]
Mean of Dependent Variable	.047462	S.D. of Dependent Variable	.042368
Residual Sum of Squares	.030264	Equation Log-likelihood	165.9008
Akaike Info. Criterion	154.9008	Schwarz Bayesian Criterion	142.6935
DW-statistic	1.9234		

R-Squared and R-Bar-Squared measures refer to the dependent variable dLNCPI and in cases where the error correction model is highly restricted, these measures could become negative.

Table A7: Cointegration results for model III.

Testing for existence of a level relationship among the variables in the ARDL model				

F-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
9.1988	2.8163	4.1183	2.3745	3.5435
W-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
55.1926	16.8978	24.7098	14.2470	21.2610

Table A8: Diagnostics

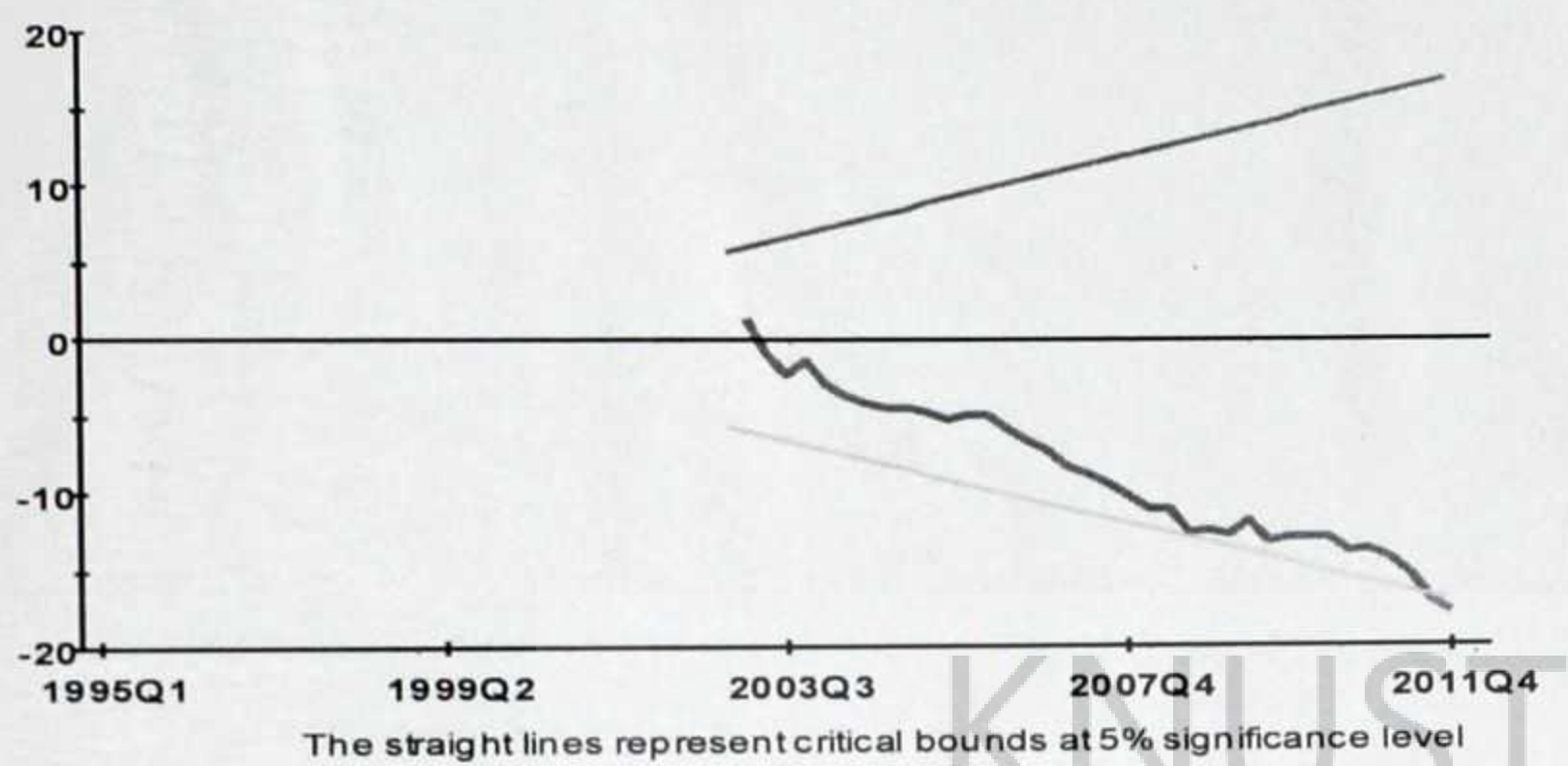
Diagnostic Tests	

* Test Statistics	* LM Version * F Version *

* A:Serial Correlation	* CHSQ(4)= 6.8724[.143] * F(4, 53)= 1.4897[.218] *
* B:Functional Form	* CHSQ(1)= .45062[.502] * F(1, 56)= .37358[.544] *
* C:Normality	* CHSQ(2)= .069406[.966] * Not applicable *
* D:Heteroscedasticity	* CHSQ(1)= 2.7050[.100] * F(1, 66)= 2.7342[.103] *

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Plot of Cumulative Sum of Recursive Residuals



Plot of Cumulative Sum of Squares of Recursive Residuals

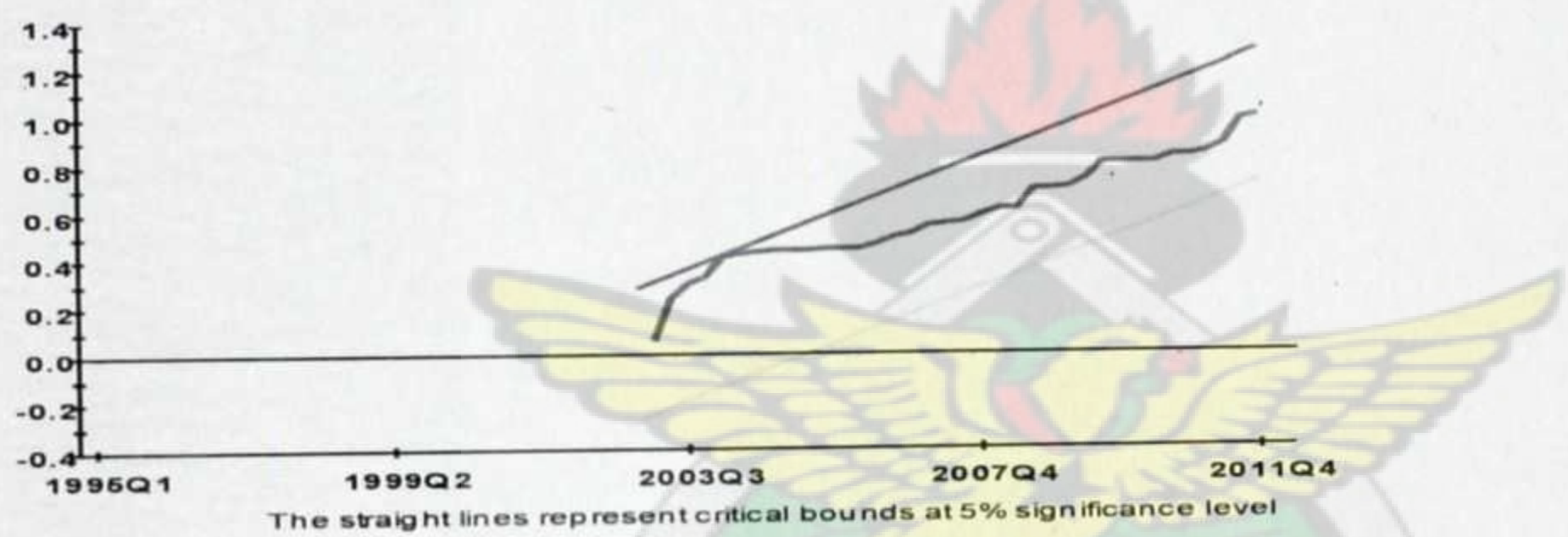


Figure A2: CUSUM and CUSUMQ test for parameter consistency.