Original Research Article

Economic Growth Implications of Inflation Targeting and Inflation Volatility: An Emerging Economy's Perspective

Abstract

Purpose: The purpose of this study was to examine the extent to which inflation targeting and inflation volatility impact on economic growth from an emerging economy's perspective.

Methodology: Annual data from the World Development Indicator (WDI) and the Bank of Ghana (BoG) from 1985 to 2014 were used for the study. The data was interpolated into quarterly series using E-views. The stationarity characteristics of the variables were tested using the Augmented Dickey-Fuller and the Phillip-Perron unit root tests. The GARCH (1 1) and ARDL models were employed for the analysis.

Findings: The study found that inflation targeting had a positive significant effect on economic growth in Ghana. Also, despite the volatile nature of inflation in Ghana, it had no significant effect on economic growth.

Implications: This scholarly work would aid policy makers in policy formulation pertaining to infaltion targeting and inflation volatility on economic growth. It will also open up the circles of knowledge regarding the monetary policy regime in empirical literature, academic institutions and the understanding of the general public. The study recommends that the Bank of Ghana should maintain its current monetary policy framework - Inflation Targeting, but should strengthen the preconditions and subsequent requirements of the monetary policy in order to maximize the gains to economic growth.

Keywords: Monetary Policy, Inflation Targeting, Inflation Volatility, Economic Growth and Ghana.

JEL Classification Code: E31, E52 & O47

1.0 Introduction

Skeptics of Inflation Targeting (IT) Monetary Policy (MP) framework are worried about the regime's capability to foster and sustain economic growth and development. They make their case through the disposition that the regime is primarily concerned with inflation, and that the drive to control inflation would lead to instability in the real sector of the economy, which will inevitably have a detrimental impact on economic growth (Friedman & Kuttner, 1996; Friedman, 2002 and Cecchetti & Ehrmann, 2002). Despite these concerns, the increasing number of economies that have adopted inflation targeting since New Zealand's first adoption in 1990, is a prima facie evidence of its success.

Ghana adopted and piloted inflation targeting for five-years until 2007 where a public announcement was made of its adoption. The monetary authority justified the move and the critical need for the policy swich on attempts to minimize and contain inflation, stabilize prices, and increase transparency (Kyereboah-Coleman, 2012). The general proclamation after Ghana's adoption of IT in 2002 has been that, inflation targeting is a nominal anchor and a mojor contributor to the relative stabile inflation rtaes in recent years, particularly the resilient nature of the Ghanaian economy amidst the global recession and financial crisis - with inflation reaching a single digit in 2011.

In understudying and authenticating these assertions about IT, Kyereboah-Coleman (2012) investigated the impact of inflation targeting on inflation management in Ghana. The findings of the study indicated that, since its inception, inflation targeting has had a significant impact on both the reduction and control of inflation series, as well as the persistence of inflation series. A cursory descriptive analysis of the inflation series data validates the proposition of Kyereboah-Coleman (2012), where it was evident that, average inflation fell from 27.48% in 1985-2001 to 14.09 % in 2002-2014. Inflation volatility had also decreased, with the standard deviation of about 11.33% to 4.10% in same periods respectively (World Development Indicators, 2016).

Despite the policy's obvious effectiveness in containing inflation, it is not clear whether the gains of the policy in containing inflation have translated into economic growth in Ghana. Puni and Osei (2014) used time series data from 2000 to 2013 to study the impact of inflation targeting on the inflation rate and gross domestic product in Ghana. The test of mean difference and regression were used to examine this. The results revealed that the mean inflation rates for the pre- and post-inflation targeting periods differed significantly. Puni and Osei (2014) also found that inflation targeting has no statistical impact on Ghana's GDP. The findings of Puni and Osei might however be problematic since they fail to control for other economic variables that may impact on economic growth. This might have a significant impact on their results and that the relationship needs to be investigated further.

Also, Marbuah (2011), found that an inflation rates of 6% to 10% would be beneficial to Ghana's economic activity. Similar findings were also espoused by Frimpong and Oteng-Abayie (2010), where inflation rates of more that 11% were seen to significantly hurt economic growth in Ghana. However, amidst the findings of Marbuah (2011); Frimpong and Oteng-Abayie

(2010), it was still observed that, even after adopting IT, Ghana has in most times failed to attain optimal inflation rates. For example, Ghana's inflation rates in 2008, 2009, 2013, 2014, and 2015 were 16.5%, 19.3%, 11.6%, 15.5%, and 17.1%, respectively (World Development Indicators, 2016). These also raised issues of whether IT policy framework has had any influence on Ghana's economic activity and growth.

Within the context of economic literature, preponderance amounts of literature have tried to examine the economic growth, inflation targeting and inflation volatility nexus. Despite thses, the Ghanaian comtext is still gray with some major issues still lingering for redress with regard to the adoption of inflarion targeting monitary policy. In this context, the few that have tried to study the subject matter lack some considerable issues (inflation volatility under the policy regime on economic growth) worthy of examination in advancing the credibility and relevance of the policy framework in Ghana (Kyereboah-Coleman, 2012; Puni & Osei, 2014). Also, the findings of Marbuah (2011); Frimpong and Oteng-Abayie (2010), make it imperative to critically understudy the economic growth impact of inflation targeting in Ghana. This is because, even after the adoption of IT, Ghana substancially is still unable to achieve optimal inflation rates the are a catalyst to economic growth. The question then is, has the policy regime really impacted on economic growth? The motivation for this study therefore, is to fill in the gaps identified by examining the economic growth implications of inflation targeting and inflation volatility in Ghana. The study is also imperative because, country specific conditions play a critical role in determining the direction of influence of the policy framework on economc growth.

The other sections of the paper are organized as follows; section two provided a theoretical basis for the study, section three looked at the trend analysis of inflation for the period under consideration and a review of empirical literature, section four considered the research methodology and the final sections, five and six examined the results and discussions and the conclusions and recommendations respectively.

2. Theoretical Review

2.1 The Quantity Theory of Money (QTM)

2.1.1 Quantity theory of money and inflation volatility

Under the QTM, the level of inflation in an economy at any given time is a monetary induced phenomenon. This means that, the level of inflation changes with variations in money stock under the assumptions of a constant velocity of money in circulation and constant number of transactions. Inflation volatility is the fluctuations experienced in the levels of inflation over a period of time. This means that volatility is directly under the influence of rampant changes in the level of inflation, where the change in inflation invariably, as per the QTM is also under the influence of the money stock.

Under inflation targeting, the monetary policy rate is an indispensable monetary policy tool. It is used to regulate the amount of money in circulation (money stock). This is achieved through the manipulation of the policy rate. In the event of an increase in the policy rate, loanable funds become expensive, thereby reducing the amount of currency in circulation. The reduction in

currency in circulation under the QTM will cool off the economy and reduce the level of inflation in the economy. However, when there is a reduction in the policy rate, loanable funds become less expensive, thereby stimulating economic activities and consequently, an increase in the level of inflation. Based on the foundations of the QTM, it can be deduced that, the monetary policy rate which is the major policy instrument under inflation targeting, when frequently manipulated, all other things being equal, could impact on inflation volatility. This therefore may lead one to hypothesize that inflation targeting has an impact on inflation volatility.

2.1.2 The quantity theory of money and economic growth

Milton Friedman espoused that a change in money supply will affect the general price level as long as the demand for money is stable and that such a change to a large extent equally affects the real value of national income and economic activity, but this is possible in the short run. This implies that, changes in money stock can affect the real value of national income and economic activity which could have implications on economic growth. The QTM states that money supply has a direct and proportional relationship with the price level and economic growth.

The expression of the theory in translating into economic growth can be seen in the Fisher's equation of exchange expressed below;

$$M \times V = P \times T \qquad (1)$$

Where:

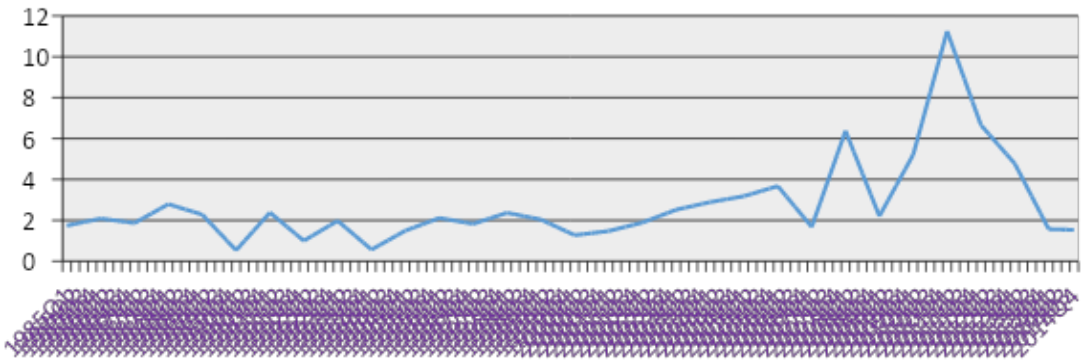
M: is the money stock in the economy
V: represents the velocity of money in circulation
P: is the average general price level
T: represents the number of transactions in the economy

From the above, *"V"* which represents velocity of money in circulation is assumed to be constant over time, also the economy is seen to be at its full employment level, and this means that "*T"* which represents the number of transactions in the economy is also constant. Under these assumptions, *"P×T"* represents national income. This means that an increase in money supply *"M"* will have a direct proportional effect on price *"P"* and by extension national income *"P×T"*. Therefore, theorizing inflation targeting and economic growth base on QTM is demonstrated through the use of the monetary policy rate (MPR) as a major policy instrument. The MPR, when manipulated, affects money supply and under a constant *"V"* and *"T"* affects prices and economic growth as well. Changes in money supply can affect aggregate demand and investment expenditures and since the major policy instrument under inflation targeting is the interest rate which when manipulated will affect money supply in an economy, will have an effect on aggregate demand and investment and consequently economic growth. However, changes in the money supply will only have an impact on real economic activity when investment spending is affected. This means that monetary policy will be ineffective if investment is not responsive to interest-rate changes (McConnell, 2005).

3.Trend Analysis of Economic Growth in Ghana

Ghana's natural resources are the primary source of revenue mobilisation for the country's economic growth and development. Ghana had promising levels of economic growth and development potential in the early years of her independence in 1957. During the 1970s and early 1980s however, the economy experienced a more than 30% economic drop. Following then, the Ghanaian economy has experienced some turbulences in terms of economic growth. Various governments have been very resolute in implementing policies and programs that could stabilize the economy and boost economic growth. Figure 1, depicts a trend analysis of Ghana's economic growth from 1985 to 2014.

Figure 1: Trend Analysis of Economic Growth



Source: Graph based on quarterised data – WDI

Figure 1, depicted the trajectory of the Ghanaian economy's performance in terms of gross domestic product per capita growth (GDPPCg) from 1985 to 2014. The graph revealed that economic growth has not been consistent over the time, but has been plagued by numerous swings.

It is noted that economic growth was high in 2008, 2010, 2011, and 2012, but economic growth was relatively low in 1990, 1992, 1994, and 2000. These patterns correspond with the post and pre inflation targeting periods respectively. The pattern as shown in Figure 1, should present a curious interest in wanting to examine further the inflation targeting and economic growth relationship in Ghana.

3.1 Literature Review

3.1.1 Relationship between inflation targeting and economic growth

Pessimists of inflation targeting continue to hold the view that inflation targeting is inimical to economic growth. Epstein and Yeldan (2009) observed that average annual GDP growth rate in Brazil under inflation targeting experienced a slower rate of growth compared to that which was recorded under exchange rate targeting regime. These findings solidified the long standing position held by Pessimists regarding inflation targeting. Howevr, other scholars continue to hold

confidence on the policy regime's ability to propel economic growth, and have demonstrated that the policy framework has superior qualities to other monetary policy regimes.

For instance, Truman (2003) brought to light a positive effect of inflation targeting on economic growth. Similar, findings were also demonstrated in Batini and Laxton (2007); Gonçalves and Salles (2008), where in analyzing emerging-market economies in perspective, they found that inflation targeting helps reduce the volatility in output growth and the output gap.

Also, Svensson (2010) justified that in both industrial and non-industrial countries; inflation targeting has demonstrated to be a flexible and robust monetary policy regime and has proven to stand the test of time in a number of shocks and turbulences including the 2009 financial crisis. Most importantly, Svensson (2010) put forward an argument that there is no evidence that inflation targeting has been harmful to economic growth, employment or economic performance measures in either developed and developing countries. As a matter of fact, inflation targeting has promoted stability in long term inflation expectation and that, no country has as a matter of fact so far abandoned inflation targeting after its adoption or even articulated any regret. In his findings, Svensson (2010) found that inflation-targeting economies experienced smaller output losses in relation to sacrifice ratio under periods of disinflation as compared to non-targeting counter parts. These stands by Svensson (2010) were further solidified by Kumo (2015), where the adoption of inflation targeting in South Africa was brought under a critical analysis. It was found that inflation targeting had a significant impact on economic growth.

However, in hyperinflation countries, inflation targeting can be very disingenuous to growth, but, Petursson (2004) affirmed that there is no evidence signifying that inflation targeting has harmful effect on growth, rather it reduces growth variability. It also sufficed to state that a vivid conclusion has been drawn on the fact that a flexible inflation targeting not only reduces inflation volatility but also growth volatility thereby promoting a more stable economic growth in countries that have adopted the policy framework (Corbo et al., 2001, Neumann & Von Hagen, 2002 and Truman, 2003).

The mixed basket of finding regarding the effect of inflation targeting on economic growth made Petursson (2004) and Genc et al. (2007) to conclud that empirical studies are unable to justify the effect of inflation targeting on the behavior of macroeconomic variables - including economic growth and inflation. Drawing inspiration form Petursson (2004) and Genc et al. (2007), it is imperative to analyze the situation in Ghana.

3.1.2 Relationship between inflation volatility and economic growth

Inflation volatility and uncertainty, according to Okun (1971), might have some impact on output and growth. This might be, because, fluctuating inflation exposes families to large fluctuations in their real net worth, thereby reducing their ability to consume goods and services. This decrease in consumption may lower output and have an impact on economic growth (Becker, 2015). The position of Becker (2015) was earlier espoused by Judson and Orphanides (1996), where it was apparent that inflation volatility is robustly negatively correlated with economic growth.

In a similar experience, Hnatkovska and Loayza (2005) undertook a study in which they controlled for some factors that could result in bias results - a nations' institutional strength,

financial depth and wealth. The results of Hnatkovska and Loayza (2005), intimated that inflation volatility has a negative effect on economic growth. It was also made manifest that this effect is greater in countries with weaker institutions, low wealth, and limited financial depth.

Siew-Voon Soon (2014) using the Asymmetric Generalized Autoregressive Conditional Heteroskedasticity model, found a positive effect of changes in the inflation uncertainty as espoused by the Friedman-Ball hypothesis, but observed that inflation uncertainty had a negative effect on output growth. However, the generality of the above studies are in a sharp contrast with the findings of Dotsey and Sarte (2000), where it was observed that there is a positive relationship between inflation uncertainty and output growth. The findings of Dotsey and Sarte (2000), resulted from the fact that, inflation uncertainty and volatility tends to promote investment through its impact on savings for precautionary purposes during uncertain economic environments.

Similarly, Narayan, Narayan, and Smyth (2009) and Jiranyakul and Opiela (2010) have equally dealt with the subject matter and more so their focus on the East Asian countries. Using the Exponential GARCH (EGARCH) model, Narayan et al. (2009) postulated that an increased inflation uncertainty reduces the average inflation. Their results also revealed that inflation variability reduced economic growth and higher output volatility has a positive effect on economic growth. This was also demonstrated in Baharumshah et al. (2011) where a negative relationship was found between inflation and its variability on output. Rother (2004) advanced that among the undesirable effects of inflation, the negative impacts of inflation volatility are of major concern. This is because, contracts are nominal, high variability of inflation over time induces expectations about future price levels and promotes uncertainty; induces risk premia for long-term arrangements and increases the costs of hedging against inflation risks, resulting in unanticipated wealth redistribution (Kumo, 2015). As a result, Rother (2004) finds that inflation volatility can stifle economic development, even if inflation is kept under control on average. Based on the empirical data presented above, it is clear that the literature on inflation volatility and economic growth nexus has a lot of conflicting findings, which could mean country specific factors may be a considerable factor – case to be examined under the current study is Ghana.

4. Materials and Methods

4.1 Data and sources of Data

The study employed secondary quarterised data for the period 1985 to 2014. This period is a composition of pre and post inflation targeting periods. The pre-inflation targeting period spanned from 1985 to 2001, and that of the post inflation targeting period is from 2002 to 2014. The span of data (1985-2014) was considered for the study given relevance to the availability of data and nature of data. There were several outliers in the inflation series reported before to 1985, which might have influenced the volatility at the time. The study omitted the period in which majority of these outliers were reported in order to prevent the impact of these outliers on the results. Additionally, some of the major variables examined in the study had missing data. These observations put together determined the study's time frame. The source of data for the study was from World Development Indicators database (WDI, 2016) and the Bank of Ghana's

(BoG) website. Inflation, gross domestic product per capita growth, broad money supply, government expenditure as a percentage of GDP and gross capital formation were obtained from the World Development Indicators (WDI) whilst real effective exchange rate was from Bank of Ghana.

4.2 Research approach, research design and study setting

A quantitative research technique was employed in the investigation. This was because of the type of data sought and the research aims set out for the study. According to Creswell (1994), quantitative research is a type of study in which the researcher attempts to explain a phenomena quantitatively and statistically. This technique, according to Leedy and Ormorod (2010), is useful when the goal of the study is to explain, confirm, and verify, or test a hypothesis.

The goal of the study was to determine how inflation targeting and inflation volatility affect economic growth. As a result, the study was best suited for a causal research design.

4.3 Empirical models

Effect of Inflation Targeting, Inflation Volatility on Economic Growth

An Autoregressive Distributed Lag (ARDL) model was adopted to examine the effect of inflation targeting and inflation volatility on economic growth. The general form of this model for time *t* is as indicated in model 1, where α and μ_t are the constant and error terms respectively, β, Ω, ϕ *and* ω are the unknown parameters to be estimated, X_t is the independent variables and Y_t represents the dependent variable.

$$\Delta Y_t = \alpha + \sum_{i=1}^{p} \beta \Delta Y_{t-i} + \sum_{i=0}^{p} \Omega \Delta X_{t-i} + \phi Y_{t-1} + \omega X_{t-1} + \mu_t \quad (2)$$

The ARDL model was adopted for the study because of the following;

It can be applied to data with different order of integration , the approach allows the model to take sufficient number of lags to capture the data generating process in a general to-specific modeling framework, a dynamic Error Correction Model (ECM) can be derived from ARDL through a simple linear transformation and this helps integrate the short-run dynamics with the long-run equilibrium without losing long-run information, the approach avoids problems resulting from non-stationary time series data and finally, this technique is also suitable for small or finite sample size.

Model 1 can be modified as follows;

$$\Delta InGDPPCg_t = \alpha + \beta 0 IT + \sum_{i=1}^{p} \beta 1 \Delta GDPPCg_{t-i} + \sum_{i=0}^{p} \Omega GKF_{t-i} + \sum_{i=0}^{p} \phi REER_{t-i} + \sum_{i=0}^{p} \delta \Delta \frac{GEX}{GDP}_{t-i} + \sum_{i=0}^{p}$$

Where:

GDPPCg= $gross\ domestic\ product\ per\ capita\ growth$

GKF= Gross capital formation

$IT = inflation\ targeting$

REER = real effective exchange rate

GEX/GDP = government expenditure as a percentage of GDP
Mgr = broad money growth
$\alpha = total\ constant$

$\mu_t = errror\ term$

$H\pi$ = inflation volatility

4.4 Measurement of Variables

Table 1- Measurement of Inflation Targeting

Variables	**Measurement of Variable**	**Source of Data**
Inflation Targeting adoption (IT)	0 = pre- adoption period (1985-2001) 1 = post adoption period (2002-2014)	Dummy
Inflation (π)	Year on year changes in consumer price index	World Development Indicators (WDI)
Inflation Volatility ($H\pi$)	Conditional variance- GARCH	WDI inflation series
Economic Growth	Gross domestic product per capital growth	World Development Indicators (WDI)
Control Variables		
Real effective exchange rate (REER)	Value of the currency against a weighted average of several foreign currencies, divided by the price deflator	Bank of Ghana (BoG)
Government expenditure (GEX/GDP)	Gross National expenditure as a percentage of GDP	World Development Indicators (WDI)
Gross capital formation (GKF)	The total value of the gross fixed capital formation, changes in inventories and acquisitions less disposals of valuables	World Development Indicators (WDI)
Broad money supply (Mgr)	Growth rates in money supply	World Development Indicators (WDI)

4.5 Volatility model (GARCH (1,1))

A GARCH model is made up of two components; a mean equation and a variance equation. The mean equation is an OLS regression with an autoregressive term and the variance equation includes a constant, ARCH and GARCH terms which account for volatility. Both the mean and variance equations are jointly estimated using the Bollerslev-wooldridge (1992) Quasi-maximum likelihood technique. The variance eaquation for the GARCH (1,1) model is specified below;

$$H\pi = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \beta_1 H\pi_{t-1+\mu_t} \quad (4)$$

Where;

ε_{t-1}^{2} = ARCH term

$H\pi_{t-1}$ = GARCH term

μ_t = error term

α_0 = constant term

α_1 and β_1 = represent the lagged squared error term (ARCH Effect) and conditional volatility (GARCH Effect) respectively.

4.6 Justification for quaterisation of data

The study sought to use a high frequency data in examining the objectives that were set out in the study. This is because, in analysing volatility under the GARCH model, high frequency data is preferred to low frequency data. The study therefore achieved this by converting annual data to quarterly data using E-Views. In carrying out the conversion, there are various methods that a study could adopt (Linear, Quadratic, Cubic, Point, Denton, Chow-Lin and Litterman methods). However, the choice of a method depends on the features and nature of the data as well as the type of variable (stock or flow variable) to be quarterised. The various in the study were both stock and flow variables. The study therefore in doing the quaterisation, adopted the Chow-Lin (1971) method. This is because the method can be applied to any dataset that contains variables with different frequencies and where there is the need to bring a dataset to the same frequency for all variables. The however, relies much on a covariance matrix, which in most incases is unknown in practice and would have to be estimated on the basis of assumptions. This notwithstanding, the efficacy of the method is not in doubt in empirical literature (Abeysinghe, & Lee, 1998).

5. Results and Discussion

5.1 Descriptive analysis of inflation and economic growth

The study conducted the descriptive statistics of inflation and economic growth. This is because they are the major variables of interest under the current study. The descriptive statistics included the mean, maximum, minimum and standard deviation. These statistics are illustrated extensively in Table 2.

Table 2-Descriptive Statistics of the Variables

Variable	Mean	Max	Min	SD
Pre- inflation Targeting				
π_t	27.48	59.46	10.10	11.33
GDPPCg	1.75	2.86	0.41	0.63
Post inflation Targeting				

π_t	14.09	26.67	8.73	4.10
GDPPCg	4.14	11.67	1.10	2.72

Source: Authors' computations

From table 2, the results showed that the data on inflation and economic growth series have significant variation in the pre and post inflation targeting periods. For instance, inflation as measured by the percentage change in the consumer price index declined from an average of 27.48% between 1985 and 2001 to 14.09% between 2002 and 2014. Variability in inflation as per the standard deviation also declined significantly from 11.33% to 4.10%. In the pre-inflation targeting period, the minimum inflation recorded was about 10.10% and a maximum of 59.46%. However, post inflation targeting recorded a minimum of 8.73% and a maximum of 26.67%. These results brought to light the fact that prior to 2002, Ghana had experienced very high inflationary levels and variability. These can be attributed to increases in world crude oil prices and decline in cocoa prices on the international market as well as the continuous depreciation of the Ghanaian cedi to major currencies. However, post 2002 which marked the inception of inflation targeting, recorded relatively low inflation rates and variability. These were achieved amidst the global financial crises and escalating crude oil prices. These may present a prima-facie evidence in support of inflation targeting monetary policy as being successful in the containment of inflation and inflation volatility.

Also, economic growth as measured by the gross domestic product per capita growth experienced an increase from an average of 1.75% between 1985 and 2001 to 4.14% between 2002 and 2014. Nevertheless, variability has equally increased with a standard deviation of about 0.63% to 2.72% over same periods. In the pre-inflation targeting period, the minimum growth recorded was about 0.41% and a maximum of 2.86%. However, post inflation targeting recorded a minimum of 1.10% and a maximum of 11.67%. These findings brought to light the fact that prior to 2002, Ghana had experienced relatively low growth levels and low growth variability. However, post 2002, which marked the inflation targeting period, recorded relatively higher growth levels. These findings could also present a prima-facie evidence in support of inflation targeting monetary policy and inflation volatility ability to propel economic growth.

5.2 Unit root test

The stationarity of variables is very key in determining the usefulness and reliability of the results in the current study. The paper examined the stationarity of the variables using the Augmented Dickey-Fuller and the Phillip-Perron methods. The results as presented in tables 3 and 4 were eminent.

Table 3-Unit root test at Levels

Level					
		ADF		**Phillips-Perron**	
Variable		**Intercept**	**Trend and intercept**	**Intercept**	**Trend and intercept**
Data period: 1985-2014					
π_t	**T-stat.**	-3.20	-4.28	-2.56	-3.39

	P-value	0.02**	0.00***	0.10	0.05*
GDPPCg	**T-stat.**	-2.28	-3.03	-2.50	-2.71
	P-value	0.17	0.12	0.11	0.23
GKF	**T-stat.**	-1.67	-0.82	-1.32	0.12
	P-value	0.44	0.95	0.61	0.99
GEX/GDP	**T-stat.**	-3.30	0.01	-3.25	-2.21
	P-value	0.05*	0.99	0.07*	0.47
Mgr	**T-stat.**	-3.22	-4.48	-3.32	-3.63
	P-value	0.02**	0.00***	0.01**	0.03**
REER	**T-stat.**	-2.06	-3.38	-8.95	-10.53
	P-value	0.25	0.05*	0.00***	0.00***

Note: * indicates significance at 10% level. ** indicates significance at 5% level and *** indicates significant at 1% level. The rejection of the null hypothesis for both ADF and Phillips-Perron unit root tests is based on the MacKinnon critical values. The lag length for the unit tests was selected automatically by Swartz information criterion (SIC) criteria (maxlag=10) and Newey-West automatic bandwidth using Bartlett kernel.

Source: Authors' computations

From table 3, it can be seen that inflation, government expenditure as a percentage of GDP, broad money supply and real effective exchange rates were stationary at levels within the specified levels of significance. This means that there was a rejection of the null hypothesis and that these variables were stationary at levels, i.e. integrated at I(0).

The variables that were not stationary at levels were further subjected to analysis at first difference and the results presented in table 4. These variables were therefore said to be integrated at I (1).

Table 4-Unit root test at First Difference

First difference		**ADF**		**Phillips-Perron**	
Variable		**Intercept**	**Trend and intercept**	**Intercept**	**Trend and intercept**
Data period: 1985-2014					
GDPPCg	**T-stat.**	-4.70	-4.75	-6.12	-6.03
	P-value	0.00***	0.00***	0.00***	0.00***
GKF	**T-stat.**	-3.22	-3.56	-3.23	-3.53
	P-value	0.02**	0.03**	0.02**	0.04**

Note: * indicates significance at 10% level. ** indicates significance at 5% level and *** indicates significant at 1% level. The rejection of the null hypothesis for both ADF and Phillips-Perron unit root tests is based on the MacKinnon critical values. The lag length for the unit tests was selected automatically by Swartz information criterion (SIC) criteria (maxlag=10) and Newey-West automatic bandwidth using Bartlett kernel.

Source: Authors' computations

5.3 Volatility results

In analyzing the effect of the variables of interest on economic growth. The study examined the nature of inflation volatility in Ghana, that is, if at all inflation series in Ghana are volatile. This was done using the GARCH (1 1) model. However, before estimating the GARCH (1 1) model in equation 3 by estimating the variance equation, the study first estimated the mean equation. The mean equation was estimated using Ordinary Least Squares (OLS) and an ARCH test was then carried out on the residual to determine if there is a conditional heteroscedasticity. The results were as presented in table 5.

Table 5- Arch test results

Series	Arch (RESID^2)	F-statistic	R-squared	P-value
Inflation	0.72	125.10	61.23	0.00***

Source: Authors' computations

From table 5, it can be seen that the ARCH test showed that there was evidence of conditional heteroscedasticity in the OLS residuals. This is confirmed by the significant coefficient of the squared residual. The implication of this result was that, inflation series in Ghana in the period under consideration contained a time varying effect, hence linear models cannot explain its behavioural pattern. There is therefore a justification for the GARCH model in the estimation of volatility in the study. Table 6 presented the results of the inflation volatility estimation.

Table 6- GARCH (1, 1) Results for Volatility of Inflation

Variable	**Coefficient**	**Robust Std. Error**	**Z-Statistic**	**P-value**
CONS	-0.01	0.05	-0.22	0.81
ARCH (α_1)	0.26	0.12	2.11	0.03**
GARCH (β_1)	0.72	0.05	13.61	0.00***
($\alpha_1 + \beta_1$)	0.98			
R-squared	0.92	S.E. of Regression		3.00
Log likelihood	-268.67			
Durbin-Watson stat.	0.53			

Note: * indicates significance at 10% level. ** indicates significance at 5% level and *** indicates significant at 1% level

Source: Authors' computations

Table 6 showed the regression results for the variance equation that examined the volatility of inflation in Ghana. It showed results for the GARCH (1,1) model which followed a Normal Gaussian Distribution. From the estimation above, the variance equation has one ARCH term (ε^2_{t-1}) and one GARCH term ($H\pi_{t-1}$). The dependent variable ($H\pi$) represented the conditional variance, $\alpha_1 and \beta_1$ represented the lagged squared error term (ARCH effect) and conditional volatility (GARCH effect) respectively. Both $\alpha_1 and \beta_1$ measured the volatility of inflation. A large error coefficient α_1 indicates that volatility reacts to economic shocks intensely, while a large GARCH coefficient, β_1 indicates that shocks to conditional variance takes a longer time to disappear, implying persistent volatility (Kevin, 2002). If $(\alpha_1 + \beta_1)$ in a variance equation is very close to one, it means that volatility is highly persistent. The results in table 6 provides evidence of high and persistent volatility in the Ghanaian inflation series in the period under consideration.

5.4 The effect of inflation targeting and inflation volatility on economic growth

An appropriate lag order was selected to calculate the F-statistics for the boubd testing to

co-integration. The lag order was selected using the Schwarz information criterion (SC) lag selection criterion. The Schwarz information criterion (SC) was chosen because it gives a more parsimonious model. Table 7 showed the estimates for ARDL bound testing approach to cointegration. The calculated F-statistics is 6.91, when gross domestic product per capita growth, gross capital formation, government expenditure as a percentage of GDP, money growth, real effective exchange rate, inflation targeting and inflation volatility are included in the model. The critical bounds generated by Pesaran, Shin and Smith (2001) have been used. The F-statistic is higher than the upper critical bound of Pesaran et al. (2001) at the 1% level of significance. This implies that there exists cointegration among gross domestic product per capita growth, gross capial formation, government expenditure as a percentage of GDP, money growth, real effective exchange rate, inflation targeting and inflation volatility for the period under consideration.

Table 7- The Results of ARDL Cointegration Test (2, 0, 1, 0, 0, 0, 1)

Test Statistic	**Value**	**K**
F-statistic	6.91***	6
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

Note: * indicates significance at 10% level. ** indicates significance at 5% level and *** indicates significant at 1% level

Source: Authors' computations

5.4.1 The Long Run Effect of inflation targeting and inflation volatility on economic growth

There existence a long run relationship among variables as reported from the cointegration test in Table 7. Table 8 presented the long run results.

Table 8- ARDL long run estimates – Dependent variable is In(GDPPCg)

Variable	**Coefficient**	**Standard Error**	**T-stat.**	**P-value**
GKF	0.26	0.14	1.78	0.07*
REER	0.01	0.01	3.77	0.00***
GEX/GDP	0.06	0.03	2.01	0.04**
Mgr	0.01	0.01	1.29	0.19
IT	0.77	0.37	2.05	0.04**

$H\pi$	0.01	0.01	0.79	0.42
C	-22.81	7.97	-2.85	0.00***

Note: * indicates significance at 10% level. ** indicates significance at 5% level and *** indicates significant at 1% level

Source: Authors' computations

Table 8 revealed that inflation targeting had a positive significant effect on economic growth. This was observed at 5% level of significance. This means that the adoption of inflation targeting resulted in an increase in economic growth by 0.77% on the average in every quarter. Also, inflation volatility had a positive insignificant effect on economic growth. This means that the volatility in inflation series does not impact in any way on economic growth over the period under consideration. The findings as presented in table 8 goes to solidify the results in the descriptive analysis, where the average GDPPCg was greater in the post inflation targeting period than the pre inflation targeting period by 2.39%. This means that, inflation targeting was very instrumental in promoting economic growth in the period under consideration. This positive impact of inflation targeting on economic growth may be as a result of its ability to clamp down inflation to some level (Kyereboah-Coleman, 2012). This reduction and containment of inflation might have impacted or improved consumer purchasing power through the increment in their real income. This will promote general consumption of goods and services or improvement in savings and investment which are key factors in economic growth. The findings of the study are consistent with Ayisi (2013) who found a positive significant relationship between inflation targeting and gross domestic product growth in Ghana. The extent of the consistency in results could be as a result of the adoption of the same estimation technique. Abo-Zaid and Tuzemen (2008) equally found a positive relationship between inflation targeting and economic growth rate for both emerging and developed countries that have adopted inflation targeting as a monetary policy framework. Similar positive effect was found in the following studies, Garcia–Solanes and Torrejon-Flores (2009); Ball and Sheridan (2003); Mishkin (2004), Corbo et al. (2001), Neumann and Von Hagen (2002) and Truman (2003). The findings of the current study were however contrary to the findings of Epstein and Yeldan (2009), where average annual GDP growth rate in Brazil was found to be lower under inflation targeting than the exchange rate targeting regime by 1.1%. Similar contradiction in findings could be seen in Batini and Laxton (2007), Gonçalves and Salles (2008) and Brito and Bystedt (2010). The contradiction in findings could be as a result of differences in estimation techniques, institutional efficiency, policy credibility and economic fundamentals. The positive significant effect of inflation targeting on economic growth was observed as result of the fact that the policy framework impacted on investment activities through the reduction in inflation; translating into expenditure reduction and increased savings.

Most of the control variables were seen to have significant impact on economic growth at the various conventional levels of significance. Specifically, gross capital formation had a positive significant effect on economic growth at 10% level of significance. This means that a unit increase in gross capital formation will increase economic growth by 0.26% every quarter. Real effective exchange rate also has a positive significant effect on economic growth at 1% level of

significance. This means that a unit increases in real exchange rate will lead to an increase in economic growth by 0.01% every quarter. Also, government expenditure as a percentage of GDP had a positive significant effect on economic growth. This was observed at 5% significance level. This means that a cedi increase in government expenditure will lead to an increase in economic growth by 0.06%. However, broad money supply was deemed to have an insignificant positive effect on economic growth. Implying money supply does not have any impact on economic growth.

5.4.2 Short Run Dynamic Results ($InGDPPCg$ ***is Dependent Variable)***

The estimated coefficient of CointEq(-1) represented the speed of adjustment which is -0.25. This means that any deviation in short run from the long run equilibrium in the economic growth model is corrected by 25% each quarter. The short run results are presented in table 9.

Table 9-Short Run Results-Dependent Variable is $In(GDPPCg)$

Variable	Coefficient	Standard Error	T-stat.	P-value
CointEq(-1)	-0.25	0.03	-7.68	0.00***
DIn(GDPPCG(-1)	0.43	0.06	-5.76	0.00***
D(GEX/GDP)	0.01	0.01	1.30	0.19
D(REER)	0.02	0.003	7.23	0.00***
IT	0.13	0.21	0.64	0.52
D(GKF)	-3.77	0.65	-5.76	0.00***
D(Mgr)	0.01	0.004	2.32	0.02**
$D(H\pi)$	0.001	0.004	0.16	0.86

R-squared	0.90	Mean dependent var	0.80
Adjusted R-squared	0.89	S.D. dependent var	0.66
S.E. of regression	0.21	Akaike info criterion	-0.13
Sum squared resid	5.00	Schwarz criterion	0.12
Log likelihood	19.03	Hannan-Quinn criter.	-0.03
F-statistic	98.71	Durbin-Watson stat	2.00
P-value (F-statistic)	0.00		

Note: * indicates significance at 10% level. ** indicates significance at 5% level and *** indicates significant at 1% level

Source: Authors' computations

Table 9 reported the short run results of the estimated Autoregressive Distributed Lag Model (ARDL) and showed that inflation targeting had a positive insignificant impact on economic growth. This means that the average quarterly economic growth under pre-inflation targeting and

post inflation targeting are not any different in the short run. Also, inflation volatility was observed to have a positive insignificant effect on economic growth. Thus, although inflation was very volatile in the period under consideration, it had no effect on economic growth in the short run. The findings in the short run means that inflation targeting does not play any instrumental role in promoting economic growth in the short run. The findings in the short run of the study are contrary to that of Ayisi (2013) who found a positive significant relationship between inflation targeting and gross domestic product growth in the short run in Ghana. The extent of the contradiction in results could be as a result of the span of the data. Ayisi (2013) considered the period 1965 to 2011, while the current study is from 1985 to 2014. Observing the trend of GDPPCg over the two periods, it can be seen that growth rate in the 1960s were very low, picked up in the 2000s and a downward trend was seen after 2011. This trend might have been the cause of the differences in the findings. The impact of inflation volatility was no different in the short run than that of the long run results. Inflation volatility had an insignificant effect on economic growth in the short. This means that inflation volatility does not affect economic growth in Ghana. The lag of GDPPCg had a positive significant effect on itself. This means that on the average, a percentage increase in GDPPCg will impact positively on economic growth each quarter. Broad money supply had a positive significant effect on economic growth unlike the long run where it was insignificant on economic growth. Real effective exchange rate was also positively related with economic growth in the short run. Surprisingly gross capital formation was seen to have a negative significant effect on economic growth in the short run. This means that a unit increase in gross capital formation will negatively affect economic growth.

5.5 Diagnostics tests

In a quest to ascertain the validity and reliability of the results estimated in the growth model, a number of post estimation tests were conducted. The regression for the ARDL indicated significant post estimation test results. The model recorded as presented in table 9 a high R-squared of 0.90 and adjusted R-squared of 0.89 implying a high predictive power of the determinants. The high R- squared showed a tight fit for the model. The R-squared therefore means that about 90.% of variations in the dependent variable are been explained by the independent variables. The F-statistic was also significant at 1%. This means that the independent variables jointly explained variations in the dependent variable. A Durbin-Watson statistic of 2.00 was also recorded; this is within the acceptable range of 1.5 to 2.5. A further postestimation tests are examined in Table 10.

Table 10: Post Estimation tests for ARDL

Test		Statistic	Conclusion
Breusch-Godfrey Correlation LM Test	Serial	F-statistic=0.98 (0.37) Obs*R-squared 2.17 (0.33)	No serial correlation

Breusch-Pagan-Godfrey Heteroskedasticity Test	F-statistic= 1.17 (0.31) Obs*R-squared 11.67 (0.30)	No Heteroskedasticity

Authors' Computations

Table 10 equally presented further diagnostics test; the Breusch-Godfrey correlation LM test result was insignificant at 10%. This is an indication of the acceptance of the null hypothesis of "no serial correlation" in the residuals. The Breusch-Pagan-Godfrey heteroscedasticity test result was also insignificant at 10%. This is also an indication of the acceptance of the null hypothesis of "no heteroscedasticity" in the residual. Table 11 presented the Ramsey RESET Test which showed that the model was well specified.

Table 11: Ramsey RESET Test

Statistic	Value	df	P-value	Conclusion
t-statistic	0.53	106	0.59	Model specification is fit
F-statistic	0.28	(1, 106)	0.59	

Source: Authors' Computations

5.5.1. Model Stability Tests

The stability of the model was also examined using the CUSUM and CUSUM of squares model stability tests. From the results as shown in Figure 2 and Figure 3, the CUSUM and CUSUM of squares tests, the model was relatively stable.

Figure 2: Cumulative Sum of recursive residuals (CUSUM)

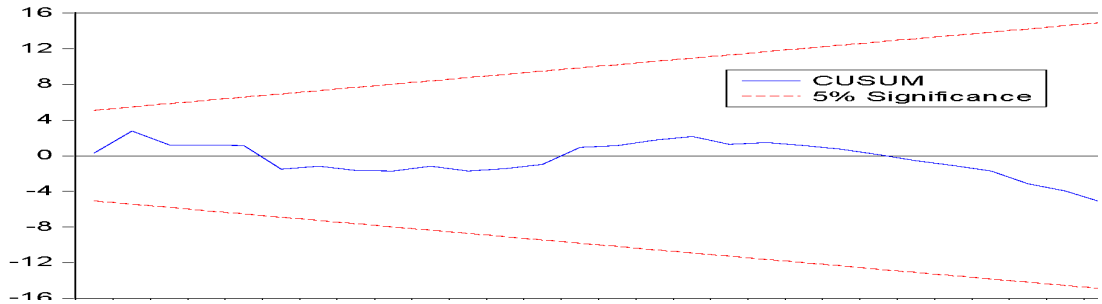
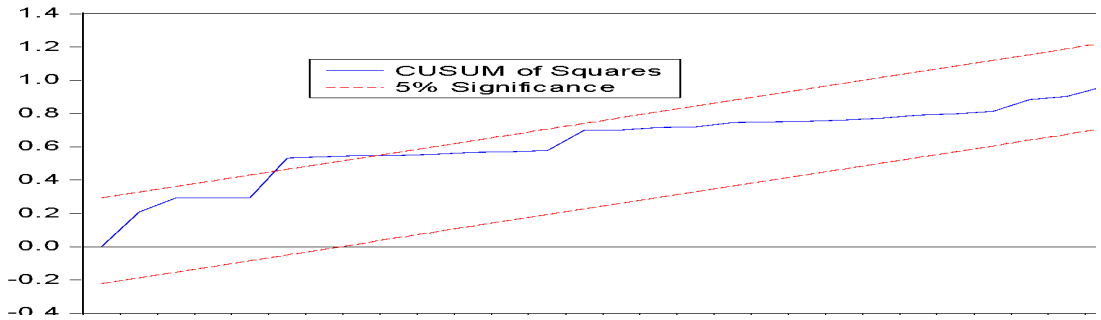


Figure 3: Cumulative Sum of squares of recursive residuals (CUSUMSQ)



6. Conclusions and Recommendations

The study made the flowing conclusions; inflation targeting had a positive significant effect on economic growth in Ghana. Also, despite the volatile nature of inflation in Ghana, it had no significant effect on economic growth. However, inflation volatility could generally affect inflation forecasting processes of individual investors and organizations, thereby increasing economic anxiety and public fears on price changes. This could have long term implications on the economy. The study recommends that the Bank of Ghana should maintain its current monetary policy framework, this will help maximize the gains to economic growth. The study also recommends that the Bank of Ghana should work to strengthening the precondition and subsequent requirements for its adoption, this will help maximize the gains thereof.

List of Abbreviations

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
ARCH	Autoregressive Conditional Heteroscedasticity
BoG	Bank of Ghana
CB	Central Bank
CPI	Consumer Price Index
EGARCH	Exponential Generalised Autoregressive Conditional Heteroscedasticity
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
IT	Inflation Targeting
MP	Monetary Policy
OLS	Ordinary Least Squares
PP	Phillip-Perron
SC	Schwarz Information Criterion
WDI	World Development Indicators

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