

Original Research Article

The Unique Adoption of Inflation Targeting Monetary Policy: Lessons from an Emerging Economy.

Abstract

Purpose: The purpose of this study was to examine the extent to which formal announcement of inflation targeting impacts on inflation and inflation volatility, from an emerging economy's experience.

Methodology: Annual time series data from 1985 to 2014, which was sourced from the World Development Indicators (WDI) and the Bank of Ghana (BOG) was used. The data was interpolated into quarterly data using E-Views. The GARCH (1 1) and AR-Newey West Models were employed.

Findings: The study found that the formal announcement of inflation targeting had a significant negative impact on inflation and its volatility. Thus, the study discovered that research works arguing that inflation targeting has no beneficial influence on inflation must take into account the type of economic structure at play, policy credibility, institutional efficiency, and the general public's responsiveness to institutional policies and information.

Implications: This scholarly work would aid policy makers, academic institutions and the understanding of the general public. This paper concludes that the formal announcement of inflation targeting contributes greatly to stabilize both the inflation rate and inflation volatility, and that, countries that adopt a piloting based adoption will not achieve the gains of the policy framework.

Keywords: Monetary Policy, Inflation Targeting, Inflation Volatility, Economic Structure, Policy Credibility, Price Stability.

1. Introduction

Monetary Policy is a primary policy framework used by Central Banks (CB) to achieve a much more relative price stability, accelerate economic growth and sustain a stable economic development in order to enhance the general welfare of citizens. In the advent of economic literature, Monetary Policy was seen to be less successful in managing inflation until the 1970s [1]. Governments in these periods relied on fiscal policy to stabilize economies and keep inflation within the appropriate range in order to boost economic activity. In the 1970s however, monetary authorities in industrialized economies attempted to control inflation using monetary aggregates (M3, M2, or M1) with some success. This perhaps was thought to be a lasting Monetary Policy regime at the time, but the instability between monetary targeting and critical economic variables (inflation and income) made this approach unsuitable in inflation management processes and the promotion of economic growth. With such instability in economic variables bedeviling monetary targeting, advanced economies shifted to Inflation Targeting (IT) in the early 1990s. In the turn of events, New Zealand was the first country to have adopted Inflation Targeting as a Monetary Policy approach in the containment of inflation in the year 1990. Evidence of inflation targeting's success in maintaining inflation led some Central Banks from industrialized and emerging economies of the third world to adopt IT as a preferred framework for Monetary Policy after it was first adopted in 1990 by New Zealand.

The profusion number of evidence in economic literature of the growing number of nations that are embracing inflation targeting as a Monetary Policy is enough prove of the success of the regime. Following New Zealand's adoption, countries such as Canada -1991, the United Kingdom -1992, Australia -1993, Sweden -1993, the Czech Republic -1997, Israel-1997, Poland -1998, Brazil -1999, Chile -1999, Colombia -1999, and South Africa -2000, among others, have adopted inflation targeting as a Monetary Policy practice [2]. All these countries in their adoption of inflation targeting as a Monetary Policy have a similar feature; a single date of adoption and formal announcement of the practicing of IT as a Monetary Policy. However, in the Ghanaian economy, the adoption and the formal announcement of the practice of inflation targeting as a Monetary Policy came under a unique feature. Thus, the Central Bank of Ghana actually adopted the policy in 2002, piloted it for about five years and subsequently made a formal announcement of the practice of the Monetary Policy to the general public in 2007. This means that there are two periods under the practice of IT in Ghana. Thus, post adoption period and post formal announcement period. This has occasioned a unique case worthy of examination in the context of Ghana. This is because, public announcements of the inflation targets to the general public is a key condition for the success of inflation targeting. However, during the piloting period in Ghana, the general public were unaware of the inflation targets that were being set. Could this have an effect on the success of the policy during this period? And is it really the case that public knowledge or awareness of the policy plays a role in its success?

The widespread consensus in Ghana is that the adoption of inflation targeting throughout the years might have contributed to inflation's relative stability in recent years, particularly the Ghanaian economy's resilience in the face of the global crisis, with inflation hitting a single digit

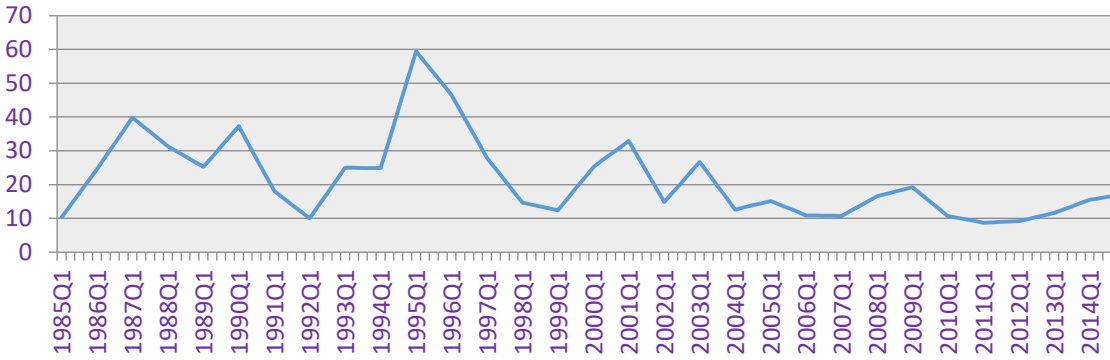
in 2011. With such considerable changes in inflation and other macroeconomic variables, the two periods (Pre-and Post-IT) can be assessed differently at best. For example, year on year inflation expressed by the percentage change in the Consumer Price Index (CPI), dropped from an average of 27.48 per cent between 1985 and 2001 to 14.09 per cent between 2002 and 2014. Volatility of inflation also dropped significantly with the standard deviation falling from 11.33% to 4.10% [3]. In the pre-IT period, the minimum inflation recorded was about 10.10% and a maximum of 59.46% compared to 8.73% and 26.67% respectively in the post-IT period [3]. These variations as a matter of fact leave so many questions answered. “Has the adoption of IT improved the management of inflation in Ghana?” “Has the adoption of IT enhanced inflation volatility in Ghana?” Answers to these questions are not readily obtainable since there are few studies that have attempted to analyse empirically the issues in perspective.

[4] examined the impact of inflation targeting on inflation management in Ghana from 1980 to 2009. The study's findings revealed that, since its adoption, IT has had a significant impact on the reduction and management of inflation series, as well as on the persistence of inflation series. However, [4] overlooked the fact that Ghana has a unique experience under inflation targeting as a Monetary Policy tool. As a result, he failed to recognise that in Ghana's inflation targeting regime, there is an adoption date (piloted phase) and an official announcement date of inflation targeting practice in Ghana. Amidst this unique feature of the Ghanaian experience with regard to the practice of inflation targeting, no study has tried to evaluate the impact of the adoption and formal announcement of IT on inflation and inflation volatility in Ghana. This however is very important considering the fact that IT generally has to do with the publicly announcement of inflation targets to the general public. Also, the public announcement has the potential to reduce individual and institutional expectations on future inflation rates change; this as a matter of fact can have an impact on the level of recorded inflation. The announcement can also help improve individual and institutional inflation forecasting processes. These therefore, make it imperative to examine the effect of IT on inflation and inflation volatility under Ghana's unique adoption.

Trend Analysis of Inflation in Ghana

Governments have as a matter of urgency instituted different policies and programmes in a bid to stabilise the economy in order to stimulate economic growth. These efforts are evidenced in the continuous fight to contain inflation within an acceptable threshold. Inflation has been termed to be a necessary evil; this is because of the double-edged role it plays in promoting economic growth – impacting positively and negatively on the growth of economies. Figure 1 observed a trend analysis of inflation in the Ghanaian economy over the period 1985 to 2014.

Figure 1: Trend Analysis of Inflation in Ghana



Source: Graph based on quarterised Data - WDI

Figure 1 showed the trend of inflation in the Ghanaian economy over the period of 1985 to 2014. The graphed showed that fluctuations in inflation rates were very eminent. As can be seen from the figure, some years recorded very high inflation rates whilst others recorded low inflation figures. For instance, 1987, 1990, 1995 and 1996 recorded very high inflation rates and 2010, 2011, 2012, 2013 and 2014 recorded low inflation rates. Most of these low inflation rates were recorded under the period of inflation targeting. This trend analysis to some extent may pre-empt the relevance of inflation targeting in the fight against inflation in Ghana.

Also, in a critical viewpoint, Umar and Dahalan (2015) used the GMM estimators to examine the Monetary Policy of IT as a nominal anchor in Ghana from 1990 to 2013. [5] suggested that the Ghanaian economy's nominal anchor is IT Monetary Policy. However, the impact of the policy on inflation volatility was not examined [5]. [6] used time series data from 2000 to 2013 to study the impact of inflation targeting on inflation and gross domestic product in Ghana. The test of mean difference and regression were used to examine this impact. The results showed that there was a significant difference between the mean inflation rates for the pre and post inflation targeting periods. However, this analysis could be problematic, since the effects of control variables are not featured in the study. [1] investigated the influence of inflation targeting on inflation volatility and inflation volatility on economic growth in South Africa. However, Ghana's unique characteristic in the practice of inflation targeting, namely the variations in the dates of adoption and formal announcement, necessitates a closer examination of the situation in Ghana. [1] did not also examine the impact of inflation targeting on inflation. Furthermore, given that different countries' IT policy framework operates differently and that the efficacy of the policy thereof depends on the county's economic structure, institutional commitment, institutional independence and efficiency, among other factors, it becomes imperative to examine the case of Ghana. Consequently, the motivation for this study is to fill in the gaps identified by examining the effect of inflation targeting adoption and formal announcement on inflation and inflation volatility in Ghana.

2.0 Methods

2.1 Data and Sources of Data

The study employed secondary quarterised data for the period 1985 to 2014. This period is made up of pre-inflation-targeting and post-inflation-targeting phases. The pre-inflation targeting era

lasted from 1985 to 2001, whereas the post-inflation targeting era lasted from 2002 to 2014. However, within the post inflation targeting era, there is an adoption phase (2002-2006) and a formal post-announcement phase (2007-2014). The type and span of data used for the study was chosen given considerations to the availability of data and nature of data. There were several anomalies in the inflation figures recorded before 1985. In order to avoid the effect of these outliers on the results, the study excluded the period in which most of these outliers were recorded. Also, prior to the 1985 and after 2014, there were missing data for some of the variables considered in the study. These together informed the choice of the time period for the study. The main sources of the data used in the study were from the website of the Bank of Ghana (BoG) and the [3]. The Bank of Ghana is the Central Bank of the Republic of Ghana and it is responsible for producing and publishing data on a number of economic variables including some of the variables considered in this study. Inflation, broad money supply and government expenditure were obtained from the World Development Indicators (WDI) whilst real effective exchange rate was from the Bank of Ghana.

2.2 Research Approach, Research Design and Study setting

A quantitative research technique was employed in the investigation. Because of the type of data sought and the research aims set out for the study, this was much appropriate to be considered. According to [7], quantitative research is a type of study in which the researcher attempts to explain a phenomenon quantitatively and statistically. This technique, according to [8], is useful when the purpose of the study is to explain, confirm, and verify theory, or to test it. The purpose of the study was to see how inflation targeting affected inflation and inflation volatility. As a result, the study was best suited to a causal research design. The study was viewed from the perspective of the current monetary policy under practice in Ghana.

2.3 Empirical Models

The Impact of Adoption and Formal Announcement of Inflation Targeting on Inflation

In order to fulfill the study's initial aims, the researchers used [9] model, which was updated. However, [9]'s model was tweaked to fit the data and objective of the study. The model used an Autoregressive (AR 2) model; using inflation targeting adoption and announcement and some theoretical based selected control variables. Thus, inflation was modeled as a function of its first and second lags, two dummy variables representing inflation targeting adoption (IT; where 0=pre-adoption and 1= post adoption) and inflation targeting formal announcement (IT1; where 0= pre-announcement and 1= post announcement) and some control variables for external shocks. The adoption of the AR model was informed by its appropriateness in similar studies considering the nature of the variables and the dataset [4]. The lags of inflation were captured to take care of possible biases due to potential correlation between the dummy variables and past performance of inflation (i.e. there is the tendency that high inflation recorded in previous periods accounted for the choice of IT).

Model 1: General Specification of Inflation Targeting and Inflation

$$\pi_t = \alpha + \gamma\pi_{t-i} + \beta_\pi IT + \beta_{\pi 1} IT1 + \delta X_{t-i} + \mu_t \quad (1)$$

Where;

π_t = inflation rates at time t

IT = inflation targeting adoption represented by a dummy variable

IT1 = inflation targeting formal announcement represented by a dummy variable

π_{t-i} = lagged of inflation

X_{t-i} = lagged of control variables

α = total constant

μ = error term

From model 1, there is the tendency that macroeconomic shocks may result in deviation of inflation rates from the target levels. This therefore, made it imperative to control for economic shocks by using variables such as broad money growth rate, real effective exchange rates and government expenditure as a percentage of GDP.

Model 2

$$\pi_t = \alpha + \gamma\pi_{t-1} + \gamma_1\pi_{t-2} + \beta_\pi IT + \beta_{\pi_1} IT1 + \delta Mgr_{t-1} + \delta_1 Mgr_{t-2} + \phi REER_{t-1} + \phi_1 REER_{t-2} + \Omega GEX/GDP_{t-1} + \Omega_1 GEX/GDP_{t-2} + \mu_t \quad (2)$$

Where;

Mgr = growth in broad money supply

REER = real effective exchange rate

GEX/GDP = government expenditure as a percentage of GDP

The Traditional ordinary least squares (OLS) yields unbiased but inefficient estimates in the event that there are serial correlation and heteroscedasticity in μ_t . The paper used a regression with Newey-West standard errors, where μ_t is assumed to be heteroskedastic and possibly auto-correlated up to some lag.

2.4 Measurement of Variables

The practice of Inflation Targeting as a monetary policy in Ghana is unique. This is because technically there are two periods within this period. The Bank of Ghana adopted the policy framework on a pilot basis before public announcement or publications were made to the general public about the adoption of the monetary policy. The study therefore seeking to analyse the impact of the pre and post announcement on inflation further divide the adoption period in to two - pre and post the announcement. The measurement of these periods and the other variables considered in the study are in table 1.

Table 1- *Measurement of Variables and Sources of Data for the Study*

Variables	Measurement of Variable	Source of Data
Inflation Targeting adoption (IT)	0 = pre- adoption period (1985-2001) 1 = post adoption period (2002-2014)	Dummy Variable
Inflation Targeting formal announcement (IT1)	0 = pre- formal announcement (1985-2006) 1 = post formal announcement (2007-2014)	Dummy Variable

Inflation (π)	Year on year changes in consumer price index	World Development Indicators (WDI)
Inflation Volatility ($H\pi$)	Conditional variance- GARCH	
Control Variables		
Real effective exchange rate(REER)		Bank of Ghana (BoG)
Government expenditure (GEX/GDP)	Gross National expenditure as a percentage of GDP	World Development Indicators (WDI)
Broad money supply (Mgr)	Growth rates in money supply (Broad money)	World Development Indicators (WDI)

2.5 Volatility Model (GARCH (1,1))

There are two parts to a GARCH model: a mean equation and a variance equation. The variance equation comprises a constant, ARCH, and GARCH terms that account for volatility, whereas the mean equation is an OLS regression with an autoregressive factor. The [10] Quasi-maximum likelihood approach is used to jointly estimate the mean and variance equations. The GARCH (1,1) model's variance equation is shown below:

Model 3: Volatility Specification

$$H\pi = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 H\pi_{t-1} + \mu_t \quad (3)$$

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.

Model 4: Specification of Inflation Targeting and Inflation Volatility

$$H\pi = \alpha_0 + \beta H\pi_{t-1} + \beta_1 H\pi_{t-2} + \beta_{\pi} IT + \beta_{\pi 1} IT_1 + \psi Mgr_{t-1} + \psi_1 Mgr_{t-2} + \phi REER_{t-1} + \phi_1 REER_{t-2} + \Omega GEX/GDP_{t-1} + \Omega_1 GEX/GDP_{t-2} + \mu_t \dots \dots \dots (4)$$

Where;

$H\pi_{t-i}$ = lag of inflation volatility

Mgr_{t-i} = lag of broad money supply

$REER_{t-i}$ = lag of real effective exchange rate

GEX/GDP_{t-i} = lag of government expenditure as a percentage of GDP

μ_t = error term

2.6 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 variables in the study were both stock and flow variables. The study therefore in doing the quaterisation, adopted the [11] 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. They however, relies much on a covariance matrix, which in most cases 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 [12].

3.0 Results and Discussion

4.1 Descriptive Analysis of Inflation

This section looked at inflation descriptives of the data. This is due to the fact that it is the major variable of interest in the study. The mean, maximum, minimum, and standard deviation are among the descriptive statistics. These statistics are well-illustrated in Table 2.

Table 2-Descriptive Statistics of Pre and Post Inflation Targeting Inflation Figures

Variable	Mean	Max	Min	SD
<u>Pre- inflation Targeting</u>				
π_t	27.48	59.46	10.10	11.33
<u>Post inflation Targeting</u>				
π_t	14.09	26.67	8.73	4.10

Source: Authors' computations

The data on inflation series has significant differences in the “before and after” inflation targeting eras, according to Table 2. For example, between 1985 and 2001, the average inflation as defined by the percentage change in the consumer price index dropped from 27.48 percent to 14.09 percent between 2002 and 2014. The standard deviation of inflation has also decreased significantly from 11.33 percent to 4.10 percent. The minimum inflation recorded prior to inflation targeting was around 10.10 percent, with a maximum of 59.46 percent. Post-inflation targeting, on the other hand, had a lower figure of 8.73 percent and a higher of 26.67 percent. These outcomes 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.

3.2 Unit Root Test

The relevance and trustworthiness of the current study's results are highly dependent on the stationarity of variables. The Augmented Dickey-Fuller and Phillip-Perron techniques were used to test the variables' stationarity. Table 3 showed the findings.

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.	-3.200695	-4.282785	-2.566176	-3.397886
	P-value	0.0225**	0.0047***	0.1029	0.0565*
GEX/GDP	T-stat.	-3.304509	0.006159	-3.255672	-2.212318
	P-value	0.0525*	0.9959	0.072*	0.4780
Mgr	T-stat.	-3.226630	-4.482707	-3.320660	-3.633279
	P-value	0.0210**	0.0025***	0.0161**	0.0312**
REER	T-stat.	-2.068321	-3.382643	-8.959122	-10.53638
	P-value	0.2579	0.0588*	0.0000***	0.0000***

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' computation

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).

3.3 Lag Selection Criteria

It is essential that before estimating an AR model under the Newey West approach, to determine the optimal lag length of the model. Table 4, reports on the optimal lag selection criteria based on the sequential modified LR test statistic, Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) and where * indicates lag order selected by the criterion.

Table 4- Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2010.793	NA	625850.6	36.04988	36.24406	36.12866
1	-699.6937	2411.487	0.000134	13.78024	15.52785	14.48930

2	-490.5582	354.7834	1.02e-05	11.18854	14.48957*	12.52787*
3	-442.4068	74.80664	1.41e-05	11.47155	16.32601	13.44116
4	-420.3024	31.18293	3.23e-05	12.21969	18.62758	14.81957
5	-262.8388	199.6414	7.02e-06	10.55069	18.51201	13.78085
6	-141.4991	136.5071*	3.14e-06*	9.526770	19.04152	13.38721
7	-61.11029	78.95331	3.27e-06	9.234112	20.30229	13.72482
8	27.02420	73.97002	3.45e-06	8.803139*	21.42474	13.92412

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

From Table 4 results, the optimal lag selection is 2. This was based on the Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). These therefore informed the use of AR2 in the analysis.

3.4 The impact of Inflation Targeting Adoption and Formal Announcement on Inflation

The results as indicated in table 5 were determined in two steps. The first was where the estimation was done without control variables and the second had the presence of control variables to take care of macroeconomic shocks.

Table 5-AR(2) Model (Newey West) – Dependent variable is inflation

Variable	NW1				NW2			
	Coef.	Std.Err	T. stat.	P-value	Coef.	Std.Err	T. stat.	P-value
$\pi(-1)$	1.66	0.07	22.53	0.00***	1.60	0.08	21.23	0.00***
$\pi(-2)$	-0.75	0.07	-11.20	0.00***	-0.71	0.07	-10.27	0.00***
IT	-0.98	0.51	-1.90	0.06*	-0.67	0.65	-1.03	0.30
IT1	-0.37	0.39	-0.94	0.35	-0.94	0.60	-1.69	0.09*
Mgr(-1)					0.12	0.04	2.74	0.01**
Mgr(-2)					-0.10	0.04	-2.30	0.02**
REER(-1)					-0.07	0.07	-1.07	0.29
REER(-2)					0.06	0.06	1.03	0.31
GEX/GDP(-1)					-0.23	0.15	-1.56	0.12
GEX/GDP(-2)					0.14	0.13	1.14	0.26
C	2.61	0.49	5.32	0.00***	13.12	6.84	1.92	0.06*
R-squared				0.970899				0.978524
F-statistic				942.5173				487.5218
Prob(F-statistic)				0.000000				0.000000
WaldF-statistic				1258.175				677.6787
Prob(Wald F-statistic)				0.000000				0.000000
Durbin-Watson stat				1.976091				1.908766

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

Source: Authors' computations

From table 5, two models were estimated to examine the effect of inflation targeting adoption and formal announcement on inflation. Model one has no control variables while model two has control variables. Both models showed significant explanatory power with R-Square of 0.971 and 0.979 respectively. These are confirmed by their respective F-values of 942.52 and 487.52 respectively, both of which are also significant (p-value = 0.000). These suggest that the overall

strength of the models is good. Both R^2 values suggest that approximately 97 percent and 98 percent of the variations in inflation can be explained by the variations in the whole set of the independent variables for both models. The Durbin Watson test statistic was also within the acceptable range for both models, thus 1.98 and 1.91 respectively. These indicate the absence of serial or autocorrelation. The models therefore can be considered reliable.

From table 5 and as presented in NW1, it can be seen that formal adoption of inflation targeting (IT) has a significant negative impact on inflation at 10% level of significance. Thus, inflation targeting adoption has succeeded in reducing the average quarterly inflation rates by 0.98%. However, under same model, formal announcement of inflation targeting (IT1) had an insignificant negative effect on the inflation rates for the period under consideration. This means that inflation targeting formal announcement has no statistical significant effect on inflation rate. Also, the lags of inflation itself were also observed to have a significant effect on inflation rate at 1% level of significance. Lag one had a positive significant effect. This means that a percentage increase in the inflation rate of lag one of any quarter had a positive effect on inflation by 1.66% and that of Lag two was seen to be negative and significant by 0.75%. However, the fact that inflation is not only being influenced by its own lags under the existing monetary policy, the study included some control variables to examine the actual impact of inflation targeting adoption and formal announcement on inflation. These results were presented in the second section of table 5 under NW2. From the results, after controlling for broad money supply, real effective exchange rates and government expenditure as a percentage of GDP, inflation targeting adoption had a negative insignificant effect on inflation. The formal announcement on the other hand was negatively significant at 10% level of significance. This means that formal announcement of inflation targeting had reduce the average quarterly inflation rates by 0.94%. These findings are consistent with [4], where in a quest to examine the impact of inflation targeting on the management of inflation in Ghana under an autoregressive model using the Newey West (NW) approach, inflation targeting was found to have a significant negative impact on inflation in Ghana [4], considered the entire adoption period]. These findings are consistent because they employed the same estimation technique in the analysis (Autoregressive Model-Newey West). The findings of the study are also consistent with [¹³] as well as [¹⁴] where the difference in difference estimator was used and inflation targeting was found to have a negative significant effect on inflation. This means that in relation to the first objective, adoption of inflation targeting had an insignificant negative effect on inflation, but the formal announcement had a significant negative effect on inflation. This means that the formal announcement of the country's inflation target to the general public contributed in the management and control of inflation in the country. This could be as a result of the reduction in expectations and anxiety of the general public towards future expectations of inflation rates change as well as the announcement helping in organizational and individual inflation rates forecasting processes. This therefore means that the period of piloting the policy framework had no significant effect on inflation. The findings of the study were however contrary to that of [¹⁵] where inflation targeting was seen to have an insignificant effect on inflation. In [¹⁶] and [¹⁷] similar findings were

espoused about IT's inability to control inflation. [18] asserted that IT should advance the level of transparency of monetary policy, since it makes it easier for the public to understand the notion of the inflation rate somewhat than other potential formal goals such as the money supply or exchange rates. This will reduce public anxiety and allay their fears about the level of inflation in the economy, which will avert frequent inflation changes and hence volatility [18]. These findings by [18] made solid the findings of the current study which the formal announcement contributes to.

3.5 Analysis of Volatility Results

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 6.

Table 6- Arch test results

Series	Arch (RESID^2)	F-statistic	R-squared	P-value
Inflation	0.722	125.10	61.23	0.000***

Source: Authors' computations

From table 6, it can be seen that the ARCH test showed that there is evidence of conditional heteroscedasticity in the OLS residuals. This is confirmed by the significant coefficient of the squared residual. The implication of this result is that the inflation series in Ghana in the period under consideration contained a times 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 7- GARCH (1, 1) Results for Volatility of Inflation

Variable	Coefficient	Robust Std. Error	z-Statistic	Prob.
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	0.927800	S.E. of Regression		3.001586
Log likelihood	-268.6717			
Durbin-Watson stat.	0.534240			

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

Source: Authors' computations

Table 7 showed the regression results for the variance equation that examines the volatility of inflation in Ghana. It showed results for GARCH (1,1) model which followed a Normal Gaussian Distribution. From the estimation in table 7, the variance equation has one ARCH term (ε_{t-1}^2) and one GARCH term ($H\pi_{t-1}$). The dependent variable ($H\pi$) represented the conditional variance, α_1 and β_1 represented the lagged squared error term (ARCH effect) and conditional

volatility (GARCH effect) respectively. Both α_1 and β_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 [19]. If $(\alpha_1 + \beta_1)$ in a variance equation is very close to one, means that volatility is highly persistent. The results in table 7 provides evidence of high and persistent volatility in the Ghanaian inflation series in the period under consideration.

3.6 The Effect of Inflation Targeting adoption and formal announcement on Inflation Volatility

The GARCH (1, 1) model estimated in table 7 revealed a strong GARCH effect in inflation series data. This means that inflation was very volatile in the period under consideration. However, it is important we examine the impact of inflation targeting on such volatility. These results are presented in table 8.

Table 8- AR(2) Model (Newey West) – Dependent variable is inflation volatility

Variable	NW1				NW2			
	Coef.	Std.Error	T. stat.	P-value	Coef.	Std.Error	T. stat.	P-value
H π (-1)	1.54	0.10	14.76	0.00	1.51	0.10	15.69	0.00***
H π (-2)	-0.66	0.11	-5.94	0.00	-0.64	0.09	-6.94	0.00***
IT	-0.98	0.51	-1.92	0.06	-1.16	0.70	-1.66	0.09*
IT1	-0.59	0.37	-1.58	0.12	-0.97	0.56	-1.75	0.08*
Mgr(-1)					-0.02	0.01	-2.01	0.053*
Mgr(-2)					0.02	0.02	1.02	0.31
REER(-1)					-0.04	0.014	-2.8	0.04**
REER(-2)					0.01	0.03	0.29	0.77
GEX/GDP(-1)					-0.06	0.08	-0.72	0.47
GEX/GDP(-2)					-0.004	0.06	-0.08	0.93
C	1.72	0.73	2.37	0.02	10.34	6.82	1.52	0.13
R-squared				0.949183	R-squared	0.951045		
F-statistic				522.9998	F-statistic	205.9263		
Prob(F-statistic)				0.000000	Prob (F-statistic)	0.000000		
WaldF-statistic				847.3876	Wald F-statistic	352.1289		
Prob(Wald F-statistic)				0.000000	Prob(Wald F-statistic)	0.000000		
Durbin-Watson stat				1.947428	Durbin-Watson stat	1.958864		

Source: Authors' computations

From table 8 and as presented in model six (NW1), it can be seen that the formal adoption of inflation targeting (IT) has a significant negative impact on inflation volatility at 10% level of significance. Thus inflation targeting adoption has succeeded in reducing the average quarterly inflation volatility by 0.98%. However, under the same model, the formal announcement of inflation targeting (IT1) had an insignificant negative effect on the inflation volatility for the period under consideration. This means that inflation targeting formal announcement has no statistical significant effect on inflation volatility. Also, the lags of inflation volatility itself were observed to have a significant effect on inflation volatility at 1% level of significant. Lag one had

a positive significant effect. This meant that a percentage increase in the inflation volatility of lag one for any quarter had a positive effect on inflation volatility by 1.54% and that of Lag two was seen to be negative and significant by 0.66%. However, the fact that inflation volatility is not only being influenced by its own lags and inflation targeting; the study included some control variables to examine the actual impact of inflation targeting adoption and formal announcement on inflation volatility. These results were presented in the second section of table 8 under model 4 (NW2). From the results, after controlling for broad money supply, real effective exchange rates and government expenditure as a percentage of GDP, inflation targeting adoption still had a negative significant effect on inflation volatility at 10% level of significance. The formal announcement of inflation targeting also became negatively significant at 10% level of significance. This means that both inflation targeting adoption and formal announcement of inflation targeting had significant negative effect on inflation volatility. The findings are consistent with [20], where under the difference-in-difference methodology, Latin American *inflation targeters* had experienced decrease in inflation volatility. The policy framework was also seen to be successful in controlling inflation volatility in studies such as [21]; [22]; [23]; [14] and [24]. The findings of the study are however contrary to that of [25] where inflation was very volatile in emerging economies that adopted the policy framework. However, the impact of the effect is much felt under the formal adoption with a coefficient of 1.16% compared with 0.97% under formal announcement. The lags of inflation were also seen to be significant with lag one being positive 1.51% and lag two being negative 0.64%. Broad money supply and real effective exchange rates were found to have no significant effect on inflation volatility.

4.0 Conclusions

The study found that the formal announcement of inflation targeting had a substantial negative impact on inflation in Ghana. Thus, the study discovered that research works arguing that inflation targeting has a beneficial influence on inflation must take into account the type of economic structure at play, policy credibility, institutional efficiency, and the general public's responsiveness to institutional policies and information. During the time period under examination, inflation was likewise perceived to be quite erratic. Inflation was also seen to be very volatile in the period under consideration, but inflation targeting was observed to have a negative significant effect on inflation volatility in Ghana. Based on the findings of the study, the following are recommended; First, Central Banks, and specifically monetary policy committees, should remind the business community and the general public of the country's inflation targets on a quarterly basis to help improve inflation forecasting and reduce inflation expectations and anxiety, which will allay public concerns about price changes. Secondly, countries that are yet to adopt inflation targeting should not do so on a piloting basis and finally, the Bank of Ghana should maintain its current monetary policy framework and work on strengthening the precondition and subsequent requirements for its adoption, this will help clamp down inflation and its volatility.

List of Abbreviations

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
AR	Autoregressive
ARCH	Autoregressive Conditional Heteroscedasticity
BoG	Bank of Ghana
CB	Central Bank
CPI	Consumer Price Index
FPE	Final Prediction Error
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
GMM	Generalised Methods of Moments
HQ	Hannan-Quinn Information Criterion
IT	Inflation Targeting
MP	Monetary Policy
NW	Newey West
OLS	Ordinary Least Squares
PP	Phillip-Perron
SC	Schwarz Information Criterion
WDI	World Development Indicators

Reference

- ¹Kumo, W.L. (2015). Inflation Targeting Monetary Policy, Inflation Volatility and Economic Growth in South Africa. African Development Bank Group-Working paper series. No. 216
- ² Jahan, S. (2012). Inflation Targeting: Holding the Line, Finance and Development, IMF; 28 March 2012
- ³ World Development Indicators, (Various years). <https://blogs.worldbank.org/opendata/world-development-indicators-2016-now-available>
- ⁴ Kyereboah-Coleman, A. (2012)."Inflation targeting and inflation management in Ghana", Journal of Financial Economic Policy, Vol. 4 -25 – 40
- ⁵ Umar, M., & Dahalan, J. (2015). The monetary policy of inflation targeting as a nominal anchor: the Ghanaian experience
- ⁶ Puni, A., Osei, B. A., & Barnor, C. (2014). Effects of Inflation Targeting Policy on Inflation Rates and Gross Domestic Product in Ghana. European Journal of Business and Management. Vol.6, No.21.
- ⁷Creswell, J. (1994). W. (1994). Research design: Qualitative and quantitative approaches. Thousand Oaks.
- ⁸ Leedy, P. D., & Ormrod J. E. (2010). Practical research planning and design (9th Ed.). New Jersey, NY: Pearson Education Inc.
- ⁹ Petursson, T. (2004). The Effects of Inflation Targeting on Macroeconomic Performance. Central Bank of Iceland, WP. 23.
- ¹⁰ Bollerslev, T. & Wooldridge, J. M. (1992). Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariance. Econ Rev 11(2):143-172
- ¹¹ Chow, G. C., & Lin, A. L. (1971). Best linear unbiased interpolation, distribution, and extrapolation of time series by related series. The review of Economics and Statistics, 372-375.

-
- ¹² Abeysinghe, T., & Lee, C. (1998). Best linear unbiased disaggregation of annual GDP to quarterly figures: the case of Malaysia. *Journal of Forecasting*, 17(7), 527-537.
- ¹³ Johnson, D. R. (2002), "The effect of inflation targeting on the behaviour of expected inflation: evidence from an 11 country panel", *Journal of Monetary Economics*, Vol. 49-1521-38.
- ¹⁴ Vegaa, M., & Winkelried, D. (2005) "Inflation targeting and inflation behavior: a successful story?" *Macroeconomics Econ WPA*. 2005
- ¹⁵ Neumann, M. J. M., & Von Hagen, J. (2002), "Does inflation targeting matter?", Federal Reserve Bank of St Louis Review, Vol. 84 No. 4-127-48.
- ¹⁶ Benati, L. (2004), "International evidence on inflation persistence", mimeo, Bank of England Working Paper Series, Bank of England, London.
- ¹⁷ Angeriz, A., & Arestis, P. (2008), "Assessing inflation targeting through intervention analysis", *Oxford Economic Papers*, Vol. 60 No. 2-293-317.
- ¹⁸ Mishkin, F. S. (2000). Inflation targeting in emerging-market countries. *The American Economic Review*, 90(2), -105-109.
- ¹⁹ Kevin, D. (2002). Measuring market risk. New York, JWS
- ²⁰ Brito, R. D., & Bystedt, B. (2010). Inflation targeting in emerging economies: Panel evidence. *Journal of Development Economics* 91, 198-210.
- ²¹ Siklos, P. L. (2008). Inflation targeting around the world. *Emerging Markets Finance and Trade*, 44(6), 17-37.
- ²² Abo-Zaid, S., & Tuzemen, D. (2008) Inflation Targeting: A Three-Decade Perspective, *Journal of policy modeling: JPMOD; a social science forum of world issues*
- ²³ Mishkin, F. S., & Schmidt-Hebbel, K. (2007), "Does inflation targeting make a difference?" Working Paper No. 12876, available at: www.nber.org/papers/w12876
- ²⁴ Cecchetti, S. C., & Ehrmann, M. (2002). Does inflation Targeting increase output volatility? An international comparison of policymakers' preferences and outcomes, in N. Loayza and K. Schmidt-Hebbel (eds.), *Monetary Policy Rules and Transmissions*, Santiago: Central Bank of Chile, 247-274.
- ²⁵ Arminio, F., Goldfajn, I., & Minella, A. (2003). Inflation targeting in emerging market economies. *NBER macroeconomics annual*, 18, 365-400.