The monetary policy of inflation targeting as a nominal anchor: the Ghanaian experience

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Abstract
The paper examines whether the Ghanaian Inflation Targeting (IT) framework has performed the role of the nominal anchor in the economy or not as well as the process through which the monetary authority determines the monetary instrument - interest rate, in the economy. Using the Generalized Method of Moments (GMM) estimators, the baseline and augmented forward-looking monetary policy rules were estimated for the pre, post-IT adoption and full sample periods. The findings vary across regimes. The result prior to the adoption of the IT framework does not follow the IT principle, whereas that of the post IT adoption and full sample periods is characterized as a forward-looking IT framework. The paper further uses the augmented monetary policy rule to identify the factors that determine the monetary policy instrument in the economy. The result confirms that the Ghanaian monetary economy practice full pledge IT principle immediately after the adoption of the IT framework and that the monetary policy rule serve as a nominal anchor for the Ghanaian economy.

Keywords: Inflation targeting, GMM, monetary policy, forward-looking rule, the nominal anchor, Ghana

JEL classification: E52, E58

1. Introduction

The practice of flexible exchange rate regime by most of the West African economies including Ghana has given the monetary authorities an opportunity of pursuing the inflation targeting framework as the economy's nominal anchor. This is usually constrained when the economy practice a fixed exchange rate regime (Torres, 2003). The nominal anchor from the perspectives of the monetary policy is a variable which the economy usually through it central bank employ to reduce the general price level or manipulate towards achieving the objective of price stability in the economy (Bassey & Essien, 2014; Torres, 2003). This is argued to ensure general macroeconomic stability with growth in the aggregate output determined by the supply factors and technological development.

The Ghanaian economy has experienced a considerable amount of changes in its monetary policy framework especially after the enforcement of the Economic Recovery Programme in 1983 and the Structural Adjustment Programme of 1986. The Bank of Ghana pursued price stability as it main objective using the traditional instrument and later improved to the market-based instruments (Addison, 2001). Starting from the 1980s the monetary authorities continuously targeted the broad money supply. The policy was constrained by the unplanned fiscal requirement. The management of inflation in the economy was based on the fluctuation in the monetary aggregate (Ewusi, 1997; Lawson, 1996). The phenomenon led to money supply growth targeting in an attempt to target inflation by the monetary authorities. This was derived from the quantity theory of money and targeted in three stages comprising the operating target, the intermediate target as well as the ultimate target. All these targets are specified in terms of the rate of inflation.

During the period prior to 1983, Bank of Ghana adopted M1 and later M2 before it switched to M2+ in 1997 as its instruments of money targeting. Alongside the monetary targeting using M1 and M2, the exchange rate policy was fixed with exchange rationing and occasional devaluation. The movement to floating exchange rate regime in 1988 resulted to *cedi* and macroeconomic instability (Mumuni & Owusu-Afriyie, 2004). The instrument of monetary management later shifted to the rate of interest. Despite the rate of improvement in the reduction of the inflation rate, yet the objective of realizing a single digit have not been achieved. The inability largely depend on the deficiency of the Ghanaian money market (Addison, 2001).

The bank use reserve targeting as an instrument of exchange rate policy where the monetary policy of outright forex sales is employed to restore back reserve to its target level. This was practiced to clear excess liquidity in the economy. Furthermore, foreign exchange swap was introduced in 1997 to tackle the problem of reserve requirement of the commercial banks. These policies/targets became more ineffective in 2000 when the Ghanaian *cedi* experience sharp depreciation that affected the exchange rate of the economy. The depreciation of the *cedi* prompted the monetary authority to use implicit Inflation Targeting (IT) in 2000 before the adoption of the full pledged IT in 2007 (Bassey and Essien, 2014). This correspond to the continuous increase in price stability and decrease in the persistence of inflation which reduces the Ghanaian inflation to single digit from the first quarter of the 2011 to date (Bank of Ghana, 2015).

This research is motivated by the success Ghana recorded in reducing the rate of inflation from three digits in the 1980s to two digits in the late 80s and currently one digit after implementing the inflation targeting framework under the floating exchange rate regime. This success from the developing market economy should serves as a motivating factor for the rest of the developing countries especially in the Sub-Saharan Africa to think of the device monetary policy rule rather than the traditional policy of fixed exchange rate with probable endogenous policies from the monetary authorities especially in the less developed economies characterized with high rate of inflation in the economies.

Despite the several monetary policies implemented in the economy, the inflation rate first became a one digit level under the inflation targeting framework. Therefore, the study will empirically assess the effectiveness of inflation targeting under the flexible exchange rate regime as the nominal anchor in the Ghanaian economy. The paper further determines the potential process of determining the Ghanaian interest rate.

The present research differs from others in that; the study is carried out in a developing country of West Africa where Ghana is the only country that officially implemented such a policy in the region. The study to the best of the researchers' knowledge is the first to be conducted in the West African region. The outcome of the study will be appreciated and applied as a lesson for the inflation targeting candidate countries especially the developing countries where such kind of studies are scanty and timely. Moreover, the reasons for the inconsistencies in the literature regarding the effectiveness of inflation targeting as a nominal anchor remain unjustified. The specification as far as developing countries are concern is also an issue that is yet to be resolved.

The rest of the paper is structured as follows: Section two reviews literature. Section three gives the theoretical framework. Section four highlights the methodology. Section five describe the data and measurement of variables. Section six discusses the empirical results and section seven concludes the paper.

2. Literature review

A significant policy debatable issue that has not yet been properly dealt with is the effectiveness of inflation targeting as a nominal anchor. This result to different theoretical and empirical findings based on the differences that exist in the approaches to the various studies. This is evident in a recent research by Petreski (2012) who finds in his critical review of theoretical and empirical findings on inflating targeting, that the effectiveness of the economy under inflation targeting is still a conflicting issue. The researcher further concludes that developing countries are not well stock with credible quantitative researches in the field. This section, therefore, present the conflicting findings on the role of inflation targeting as a nominal anchor in the economy.

It has been widely argued that countries adopt inflation targeting primarily to react to inflation and monetary policies to ensure stability in inflation and other macroeconomic indicators. This argument is found in cross countries' studies by: Aizenman & Hutchison (2010); Carare & Stone (2006); Edwards (2006); Goncalves & Salles (2008); Josifidis, Allegret & Pucar (2011); Lin & Ye (2009); Lin & Ye (2012); Mendonca, Jose & Souza (2012); Yamada (2013).

Aizenman & Hutchison (2010) empirically investigate the effect of inflation targeting in 16 emerging markets using Taylor's rule regression model. They conclude that the emerging markets adopt a dual inflation targeting where the central banks set interest rate to respond to inflation and exchange rate simultaneously even though the response to exchange rate is stronger in countries that did not adopt inflation targeting. The result further shows that real exchange rate is not a robust predictor of future inflation in emerging markets. Carare & Stone (2006) develop an inflation targeting policy-oriented literature in 41 countries in which they discover that inflation targeting is best adopted by countries that opted for flexible exchange rate to reduce the vulnerability of exchange rate fluctuations thereby maintaining stability in the economy. Edwards (2006) and Goncalves & Salles (2008) explore the significance of inflation targeting on inflation and growth variability in 7 and 36 developing countries respectively. The result shows that the economies that adopt inflation targeting experience a great decrease in the level of inflation and growth variability. Josifidis, Allegret & Pucar (2011) analyze the divergence in managing exchange rate volatility in targeted inflation in some selected transition economies. The result shows that using interest rate management known as inflation targeting leads to a substantial reduction in the volatility of nominal exchange rate in the long run.

Propensity score matching in over 50 developing economies reveal strong evidence that inflation targeting reduces the rate of inflation than in the regime of exchange rate targeting. The result claim to be independent of stagnation or lower economic growth (Lin & Ye, 2009; 2012; Mendonca, Jose & Souza, 2012). It was further stress that the level of inflation targeting performance is significantly affected by the operational structures of the countries (Lin & Ye, 2009). Yamade (2013) extended the study of the effect of inflation targeting on macroeconomic stability to over 120 countries using same propensity score matching estimator. The findings conclude that inflation targeting regime result to decrease in the rate of inflation. It further shows that inflation targeting work well in ensuring a decrease in the level of macroeconomic instability in the studied economies.

The other side of the argument indicates insignificant relationship between inflation targeting and macroeconomic stability. The opposite findings were reported in Mendonca, Jose & Souza (2012) who find a contrary result for developed nations where implementation of inflation targeting does not impact significantly in reducing the level of inflation and the aggregate macroeconomic instability. In addition to the work of Mendonca, Jose & Souza a number of scholars contrarily argued that inflation targeting has negatively affected the macroeconomic stability in their countries of study. The contrary notion is found in the researches of: Berganza & Broto, (2012); Batini, Harrison & Millard, (2003); Bonser – Neal & Tanner, (1996); Dennis, (2003); Kollman, (2002); Pavasuthipaisit, (2010); Roisland & Torvik (2004) & Saborowski, (2010).

Berganza & Broto, (2012) empirically analyze the inflation targeting on exchange rate volatility. Their findings show that inflation targeting leads to higher volatility in exchange rate than the alternative regime. They, however reveal that forex intervention practiced by some inflation targeters relatively reduces inflation and exchange rate volatility compare to non-inflation targeting economies. Inflation targeting in 36 different countries is found to be less in appropriate than inflation-forecast-based rule (IFB) in lowering the average variability of inflation and exchange rate instability due to its inability to react to deviations of anticipated inflation from target (Batini, Harrison & Millard, 2003).

According to Dennis (2003) and Kollman (2002) price level targeting is more significant in the reduction of economic dynamism than inflation targeting in Australia, Japan, Germany, and United Kingdom. The results further show that inflation targeting leads to more volatile interest rate hence, optimized policy rule results to significant volatilities in both nominal and real exchange rates. Other researchers associated the menace of macroeconomic instability to the lack of independence in the central bank monetary policy formulation. Such studies include Pavasuthipaisit (2010) who examines the optimality of central bank to response to movement in exchange rate under the regime of inflation targeting in United State. The study reveal that the state of the economy is what determine exchange rate and inflation not inflation targeting. Accordingly, if the central bank can properly monitor the state of the economy there will be no gain targeting inflation or exchange rate to ensure stability in the economic operations of the country.

Nevertheless, most of the analyses were carried out under fixed or pegged exchange rate regimes which have fewer bases for effectiveness as it cannot coexist in a World of capital mobility. Inflation targeting should be best assess under a floating exchange rate regime due to the principle of "impossibility of the holy trinity" (Edwards, 2006; Carare & Stone, 2006 & Mishkin & Savastano, 2001). Another issue is that most of the findings were concluded based on the average reported coefficients in the case of studies conducted on a number of countries with heterogeneous characteristics. Therefore, countries having distinct characteristics such as the developing countries of the West African states are better studied individually especially as it relates to specific policy implementation.

3. The Theoretical Framework

This study employs the Taylor rule proposed by Taylor (1993) as a framework for monetary policy. Taylors rule is a monetary policy rule originated from the quantity theory money which specifies how nominal interest rate should be adopted by the central bank in response to changes in inflation, output and other macroeconomic variables. The rule hypothesized that an inflationary pressure increases in the economy as a result of excess aggregate demand. This leads to an upward raise in the level of inflation as well as output gap and therefore the monetary authorities will raise the rate of interest in response to the increase in the gaps of output and inflation rate. The scenario applies when the argument is considered from the cost-push inflation factor as well. However, including the deviation of the actual output from its potential quantity in the framework tend to normalize the high interest rate in response to the high inflationary rate thereby reducing it adverse effect on the economic activities (Torres, 2003). The Taylor rule in its traditional form is presented in equation one below:

$$i_t = \alpha + \beta(\pi_t - \pi_t^*) + \gamma(y_t - y_t^*) \qquad [1]$$

Where i_t is the nominal rate of interest for the time t, α represent an equilibrium nominal interest rate in the long run, β, γ are the coefficient of the inflation and output gaps respectively. The parameters measure the magnitude of deviation of inflation from its target and the actual output from its potential output respectively. In the traditional model, the values of β and γ were set to be 0.5 in each case. π_t is the rate of inflation over time and π_t^* represent the target inflation for the period. The symbol y_t and y_t^* denotes actual output at time t and the potential output over time respectively.

The prominent Taylor rule was reviewed and formalized by number of authors on how to approximate the rule through central banks process of optimization in a standard New Keynesian macroeconomic framework. The central banks try to minimize the quadratic loss function that exist in the inflation and output gaps. The formalization was found in the work of Clarida, et al.

(1999); Svensson (1996) and Woodford (2001). They further modify the Taylor (1993) policy rule and presented it forward looking version as in equation two below:

$$i_t = \alpha + \beta(\mathrm{E}_t[\pi_{t+n} - \pi_t^*]) + \gamma(\mathrm{E}_t[y_{t+k} - y_{t+k}^*]) \qquad [2]$$

Where E_t is the instantaneous expectation operator which modifies the policy rule presented in equation 1 to denote that the interest rate as a policy variable is modelled to react to the expected inflation and output gaps instead of the rate of changes in the past and present observed series of inflation and output/income. The α in Equation 2 denotes the equilibrium nominal interest rate in the long run.

The modified rule also suggests that when the expected inflation is above the target, the real interest rate should be raised through increasing the nominal rate in order to restore inflation to the target rate. This is possible through the contraction in the aggregate demand. Furthermore, the modified rule also suggests that as output rise above its potential quantity then, the same response is expected from the monetary authorities in order to curtail the effect of future inflationary pressure in the economy. However, this specification works well in developed open economies where there is a reasonable macroeconomic stability (Clarida et al., 2000).

It has been argued in the literature that in a developing small open economy such as Ghana where the monetary authorities are confronted with other macroeconomic instability such as exchange rate volatility and external financial market shocks, other variables like exchange rate, foreign interest rate can reflect the uncertainty in the expected inflation and deviation of the actual output from the potential quantity (Ball, (1999) in Torres, 2003; Svensson, 2000; Gali, Jordi & Monacelli, 2005). The policy rule was modified to capture such kind of additional variables as presented in equation three below:

$$i_t = \alpha + \beta(\mathrm{E}_t[\pi_{t+n} - \pi_t^*]) + \gamma(\mathrm{E}_t[y_{t+k} - y_{t+k}^*]) + \varphi(\mathrm{E}_t[Z_{t+m}]) \qquad [3]$$

Here the symbol φ is the coefficient of other included variables in the model and Z_{t+m} is hypothesized by Torres (2003) to represent any variable apart from inflation and output gaps that can influence the determination of the rate of interest. These include exchange rate, foreign interest rate, money supply, openness, country risk perception among others. Taylor (1993) also suggested similar variables such as money supply and exchange rate. However, in a small open economy like Ghana, exchange rate effect on inflation and output will be captured by the policy rule parameter whereas openness is expected to affect the parameters of the model not that of the overall policy rule.

Therefore, according to Torres (2003) inflation targeting would be consistent with the process through which monetary authorities determine the rate of interest, thereby a nominal anchor in the economy.

4. Methodology

Prior to the proper estimation process. The stationarity analysis was conducted using Lee and Strazicich (2003) two breaks Lagrange Multiplier (LM) test to account for structural breaks in the data generating process, overcome the problems of size distortion, location dependence and nuisance parameter estimates (Lee & Strazicich, 2013).

However, the proper estimation procedure adopted in this study is the commonly employed Generalized Method of Moment (GMM) proposed by Hansen (1982) and Hansen and Singleton (1982). The first-order condition discrete-time model can be specified below:

$$\mathrm{E}_t h(x_{t+n}, b_0) = 0 \qquad [4]$$

Where E_t represent expectation operator over time, x_{t+n} is the observed variables k dimension vector at time $t+n$ for forward-looking rule and $t-n$ for the backward-looking rule. The observed variables in this study include the interest rate, inflation rate, real output, real exchange rate, and real money supply. b_0 denotes the unknown l dimension vector of parameters estimated using the procedure of the generalized instrumental variables with orthogonality condition and criteria function that guarantee consistency, asymptotically normal distribution and consistent asymptotic covariance matrix estimators of b_0. The function *f* of the equation (5) is defined as:

$$f(x_{t+n}, z_t, b) = h(x_{t+n}, b) \otimes z_t \qquad [5]$$

Here f becomes R^r, while $r = m * q$, $\otimes$ is the Kronecker product operator, z_t represent q dimension vector of the instrument and the instrument vector is constructed using the lagged series of x_{t+n} which include the lags of interest rate, inflation rate, output, real exchange rate and real money supply. The instrument variables are not expected to be stationary but rather the need for the convergence of the moment matrix (Amemiya, 1974; Gallant, 1977 & Hansen & Singleton, 1982). The only requirement is that the $z_t\text{'}s$ need to be determined a priori at time t and not necessarily exogenous (Hansen, 1982 and Hansen & Singleton, 1982). The lags of x_{t+1} employed in z_t ranged from 1 to the maximum of 4 lags. The resulting implication of [4] and [5] is given in equation [6] below:

$$\mathrm{E}[f(x_{t+n}, z_t, b)] = 0 \qquad [6]$$

Equation 5 shows the set of orthogonality conditions that enable the construction of b_0 estimators provided that the population orthogonality conditions at least equals to the b parameters in the model. The sample information such that $\{(x_{1+n}, z_1), (x_{2+n}, z_2), ..., (x_{T+n}, z_T)\}$ as well as the vector of the unknown parameter b_0 are employed to developed the objective function.

The choice of the weighting matrix W_T influence the estimators' asymptotic covariance matrix. Assuming that the z_t vector is chosen and h can be differentiated. Then, the full rank matrix is represented in equation seven below:

$$D_0 = \mathrm{E}[\partial h / \partial b (x_{t+n}, b_0) \otimes z_t] \qquad [7]$$

The W_0 limiting constant matrix converges closely to the W_T weighting matrix given equation eight below:

$$S_0 = \sum_{j=-n+1}^{n-1} \mathrm{E}[f(x_{t+n}, z_t, b_0) f(x_{t+n-j}, z_{t-j}, b_0)'] \qquad [8]$$

Where n is the auto covariance's number of the population emanating from the u_t moving average of the disturbance term. Given the full rank S_0 condition, $W_0^* = S_0^{-1}$ in the model. This is estimated using b_T of b_0 consistent estimators. The characteristics of the estimation procedure is that adjustments in the conditioning data set influence the conditional variance of the series (Hansen & Singleton, 1982). In this situation, the lagged interest rate influence the conditional variance of the instantaneous interest rate.

For the purpose of this study, the inflation targeting monetary policy rule for Ghana will be considered under both the baseline and augmented forward-looking rule described below.

The Inflation targeting and monetary policy rule for Ghana: the baseline case

Following the work of Clarida et al. (1999); Torres (2003) the baseline monetary policy rule is estimated to determine the process followed by the Ghanaian economy to set interest rate in the economy. The Taylor rule in its simple form, models nominal interest rate as monetary policy instrument. The rule is assumed to react to deviations in inflation and output gaps in the economy. Following Orphanides (2004) the policy rule is a function of inflation and real economic activities outlook as presented in equation nine below:

$$i_t = \alpha + \beta(\pi_t - \pi_t^*) + \gamma(y_t - y_t^*) + \eta_t \qquad [9]$$

Here α represent the equality of inflation to its target policy rate in a steady state when deviation of output from its potential quantity equals to zero. The error term η_t is considered as other factors that can affect the interest rate for the period apart from the inflation and output gaps. All other symbols are as earlier defined under equation one.

In a simple forward-looking baseline case, the monetary policy rule can be described as in equation ten below:

$$i_t^* = (k + \alpha\pi_{t+n}^*) + \beta(\mathrm{E}_t[\pi_{t+n} - \pi_{t+n}^*]) + \gamma(\mathrm{E}_t[y_{t+k} - y_{t+k}^*]) \qquad [10]$$

Here the i_t^* is the target interest rate. In equation ten the long-run nominal interest rate is represented by $k + \alpha\pi_{t+n}^*$ and that both the target inflation π_{t+n}^* and the nominal interest rate are assumed to vary over time whereas the actual interest rate assumed a gradual adjustment process in converging to the target interest rate. Moreover, the actual interest rate is the combination of the lagged interest rate, the weighted average of the interest rate target and the white noise interest rate shock depicted in equation 11 below:

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + v_t \qquad [11]$$

With an estimable baseline, forward-looking monetary policy rule described in equation 12 below:

$$i_t = (1-\rho)(k + \alpha\pi_{t+n}^*) + (1-\rho)\beta(\mathrm{E}_t[\pi_{t+n} - \pi_{t+n}^*]) + (1-\rho)\gamma(\mathrm{E}_t[y_{t+k} - y_{t+k}^*]) + \rho i_{t-1} + v_t \qquad [12]$$

Where the parameter ρ indicates the magnitude of interest rate smoothening and in turn assumed the value of between zero (0) and a maximum of one (1).

Equation 12 is estimated using GMM technique following Clarida et al. (1999, 2000); Torres (2003) and Ophanides (2004) to overcome the problem that usually arise from the variable construction. The study test the hypothesis of whether the monetary policy in Ghanaian economy has fulfilled the requirement to serve as a nominal anchor and whether it represent the process through which the central bank determines interest rate from the baseline monetary policy rules.

To ascertain this assertion the monetary policy rule in its baseline case (equation 12) is estimated to see if β and γ are significantly greater than 1 and 0 respectively.

For the central bank to achieve price stability as one of its objectives, the monetary authorities will be much concern with the inflation gap compared to the output gap, a measure referred to as full-fledged inflation targeting. The Bank of Ghana, therefore, targeted inflation to achieve the objective of price stability in the economy.

Augmented simple forward-looking monetary policy rule

The augmented forward-looking rule takes into account another important set of information in addition to lagged inflation and output to predict the future situation of the economy (Clarida, et al. 2000). This version of the rule also uses interest rate as the policy reaction function in its simplest specification. The rule is a function of the expected inflation and output gaps each period coupled with their target levels. This is presented in a linear form in equation (13) following the work of Clarida et al. (2000).

$$r_t^* = r^* + \beta(\mathrm{E}[\pi_{t,k} / \eta_t] - \pi^*) + \gamma \mathrm{E}[x_{t,q} / \eta_t] \qquad [13]$$

Where r_t^* represent the target interest rate, t denotes the time period, r^* is the target interest rate when the target levels of inflation and output are achieved. β, γ are the coefficient of inflation and output gaps respectively. E and η_t indicate the expectation operator and a set of information when interest rate is determined. $\pi_{t,k}$ stand for the price level annual percentage change between t and $t+k$. π^* represents the inflation target. $x_{t,q}$ is the deviation of GDP from its potential quantity expressed in percentage. It measures the average output gap in terms of t and $t+q$.

The rule presented by equation 13 is vast recognized in both theoretical and empirical studies especially by the central banks that suffer inflation and output deviation in a quadratic loss function. Furthermore, the rule depicts the behaviour of most central banks in the World (Clarida et al. 2000). However, the rule as presented in equation 13 is found to be inflexible in describing the actual interest rate changes in many economies. This is attributed to the unrealistic assumption of the immediate reversion of the actual interest rate to its target without considering the smoothening process of the monetary authorities. The assumption of the efficiency of the central banks to have absolute control over the rate of interest through the instrument of monetary policy and finally, the way monetary authorities consider all changes in the policy rule function as it occurs based on the underlying economic situation. The noticeable difficulty in the reversion process of the interest rate. Clarida et al. (2000) specify a more realistic policy rule to depict the actual relationship using the actual interest rate r_t taking into consideration the exogenous shock and smoothening process in the model as presented in equation 14 below:

$$r* = \rho(L) r_{t-1} + (1-\rho) r_t^* \qquad [14]$$

Where $\rho \equiv \rho(1) * V_t$ stand for the exogenous zero mean interest rate shock, $\rho(L) = \rho_1 + \rho_2 L + ... + \rho_n L^{n-1}$. r_t^* is the interest rate target already specified in equation 13. ρ denotes the quantum of changes in interest rate smoothenings, anytime monetary authorities change interest rate to adjust a fraction of a given gap between the past values and the current target level. In a general form, equation 15 is presented as a combination of both equations 13 and 14.

$$r_t = (1-\rho)[rr^* - (\beta-1)\pi^* + \beta\pi_{t,k} + \gamma x_{t,q}] + \rho(L)r_{t-1} + \varepsilon_t \qquad [15]$$

In equation 15 above $\varepsilon_t \equiv -(1-\rho)\{\beta(\pi_{t,k} - \mathrm{E}[\pi_{t,k} / \eta_t] + \gamma(x_{t,q} - \mathrm{E}[x_{t,q} / \eta_t])\}$

The information set in any variable is orthogonally related to the forecast error in a linear combination way.

In equation 16 below, we let Z_t to represent a set of instrument variables exogenously determined when the monetary authority sets the interest rate. Therefore, the orthogonality condition is further presented in equation 16 below:

$$\mathrm{E}\{[r_t - (1-\rho)(rr^* - (\beta-1)\pi^* + \beta\pi_{t,k} + \gamma x_{t,q}) + \rho(L)r_{t-1}]z_t\} = 0 \qquad [16]$$

The estimable forward-looking augmented monetary policy model is further given in equation 17 below:

$$i_t = (1-\rho)(k + \alpha\pi^*_{t+n}) + (1-\rho)\beta(\mathrm{E}_t[\pi_{t+n} - \pi^*_{t+n}]) + (1-\rho)\gamma(\mathrm{E}_t[y_{t+k} - y^*_{t+k}]) + (1-\rho)\phi(\mathrm{E}_t[z_{t+m}]) + \rho i_{t-1} + v_t \qquad [17]$$

Here the additional symbol z_{t+m} represent other variables such as the real money supply and real exchange rate that can also help in determining the process through which interest rate is determined in a given economy like that of Ghana. This is considered in order to find out the function of other macro variables in determining the process through which interest rate is determined by the monetary authorities in the economy.

Equation 16 and 17 give the opportunity to estimate $(\alpha, \beta, \gamma, \rho)$ parameters using the Hansen (1982) Generalized Method of Moment (GMM) while accounting for serial correlation in $\{\varepsilon_t\}$ using an optimal weighting matrix until the vector of z_t become greater than the number of the estimated parameters. This assessment is also done considering expected inflation as the most important measure compared to the lagged inflation. The rule also follows the same process in determining the process of setting interest rate and the way in which monetary policy become a nominal anchor in the economy.

We estimate equation 17 to see if β and γ are significantly greater than 1 and 0 respectively. Additional parameter restriction is imposed to estimate inflation target π^* to characterize the monetary policy correctly in the model. Furthermore, the equilibrium real rate rr^* is derived as the average of the observed sample. The estimation is further subjected to the test of validity of the employed instruments and model specification as well.

5. Data and measurement of variables

In the process of estimating these models, a quarterly time series data spanning from the 1990Q1 to 2013Q4 has been employed on nominal interest rate, inflation rate, real gross domestic product, real exchange rate and real money supply from the Bank of Ghana and World development indicators. The quarterly data was employed to allow for wide coverage in order to account for much deviation of real output from its potential output and inflation rate from its target rate. The figures 1, 2, 3 and 4 depicted below show the plots of the data collected from the above sources. The hard lines in figure 1 and 2 indicate the plots of real interest rate and nominal interest rate respectively. While the dotted lines depict nominal interest rate and inflation rate in figure 1 and 2 respectively. Furthermore, figure 3 and 4 represent the plots of inflation and the inflation target and output and potential output respectively.

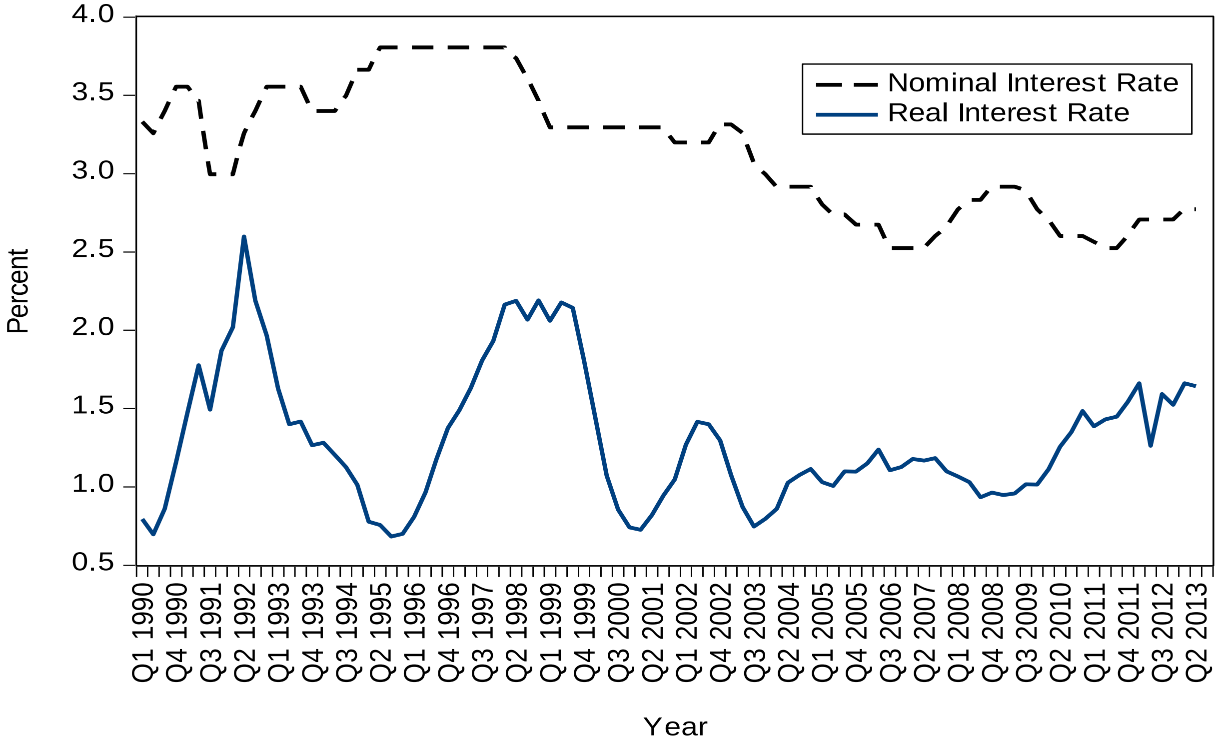

Figure 1: *Nominal and Real Interest Rate*

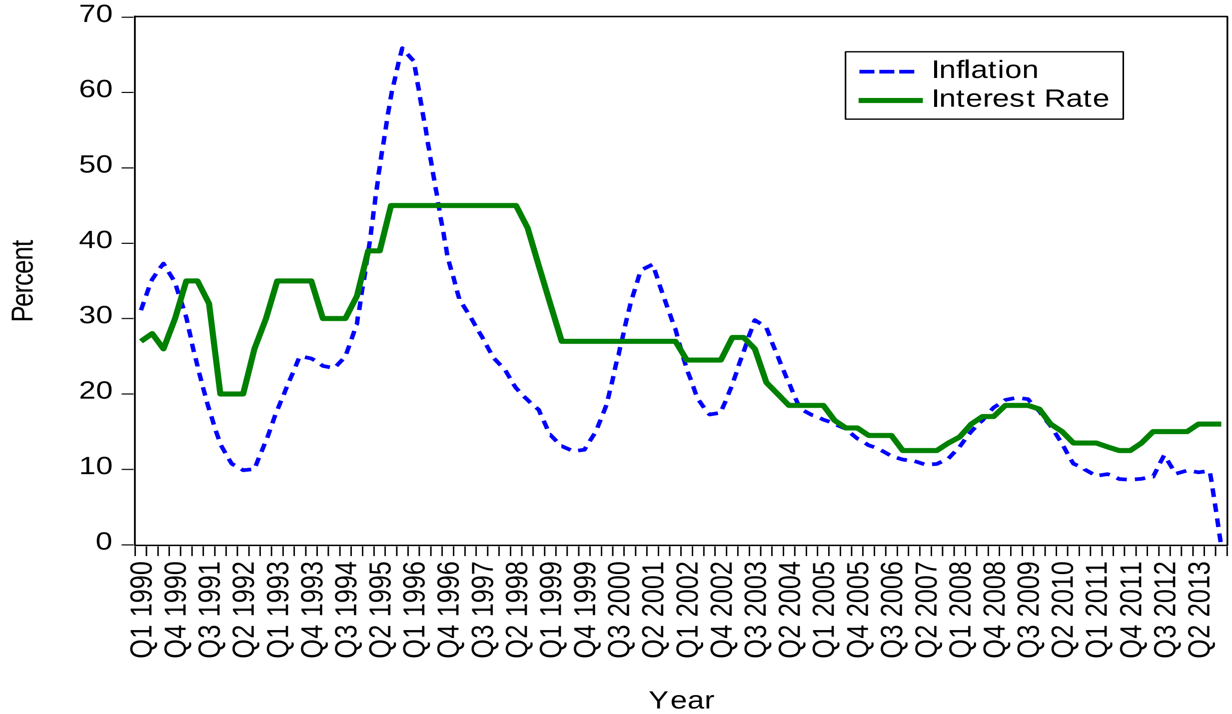

Figure 2: *Nominal Interest Rate and Inflation Rate*

Figure 1 shows that in a high inflationary economy like Ghana (prior) to inflation targeting, the real interest rate responds to sufficient rise in the nominal interest rate to reduce the aggregate demand and push inflation back to equilibrium and vice versa. This has been achieved by the Ghanaian monetary authorities as seen in figure 1 and serve a good signal for economic stabilization and nominal anchor in the economy. From figure 2 as well it is seen that inflation in the early part of 1990 was higher than the interest rate. However, starting from the second quarter of the 1991 interest rate was raised above the inflation rate until early 1995 when inflationary rate rose beyond the rate of interest. It lasted for a while and later assumed a random walk until 2007 when the policy of inflation targeting was pursued in the economy with little inflationary persistence during the World economic slump. Interest rate continues to be higher than the inflation rate since the first quarter of 2010 whereas, inflation rate keep continues decrease maintaining a single digit since 2010 in response to the target.

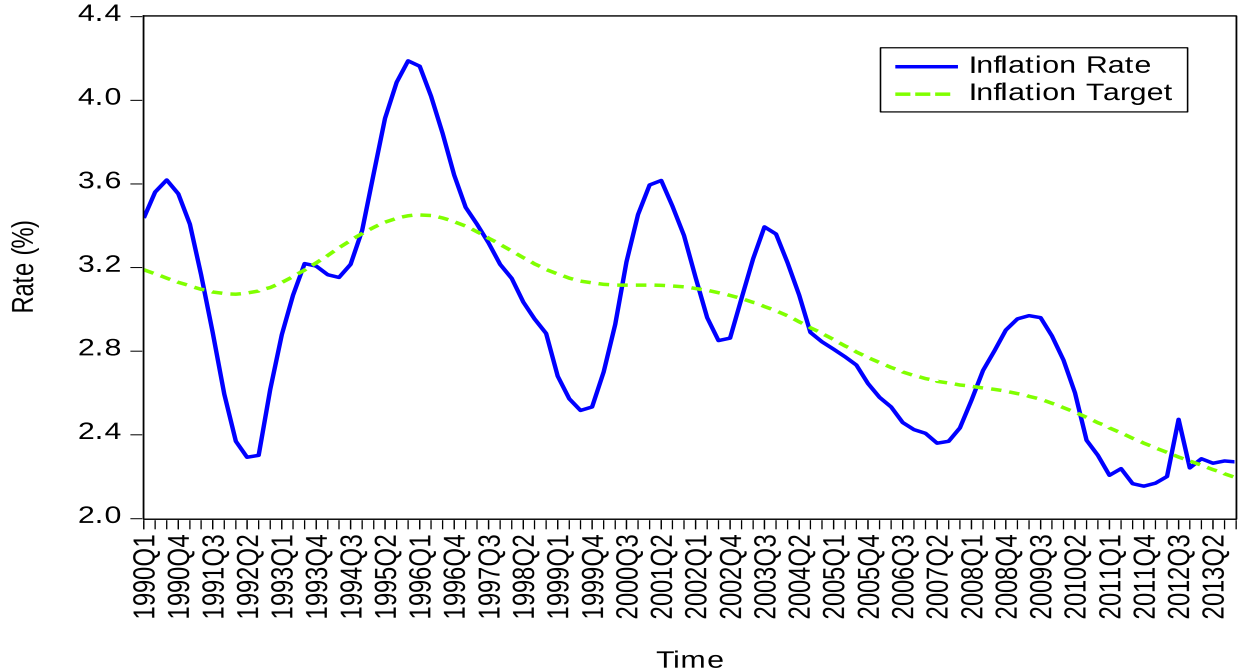

Figure 3: *Inflation Rate and Inflation Target*

The set of instruments variables are employed to ensure zero average forecast error. In this study the set of instruments include the lagged values of nominal interest rate, inflation deviation and output gap in the baseline case and extended to include lagged values of real exchange rate and real money supply in the augmented policy rule model.

Following Torres (2003); Clarida et al. (2000) the inflation deviation and output gap are measured as difference in inflation and real output from their target and potential output respectively. This is measured using the commonly employed method in the literature known as Hodrick-Prescot filter for de-trending a stochastic series. The method was proposed by Hodrick and Prescott (1980) in Pesaran and Pesaran (1997) and later re-specified for quarterly and monthly data by Harvey and Jaeger (1993). Figure 4 below present the plots of output and potential output generated following the Hodrick-Prescot (1980) filtering procedure.

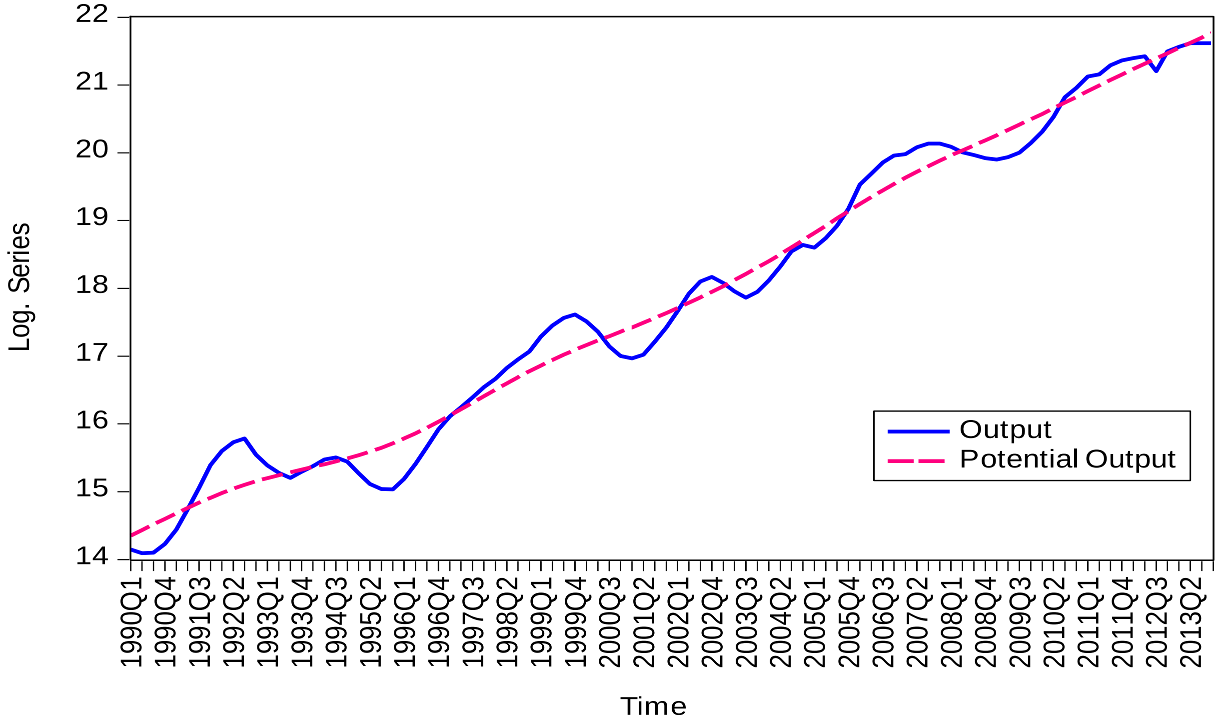

Figure 3: *Output and Potential Output*

6. Results and Discussion

Unit root Analysis

As one of the requirements of handling time series data, we checked the stationarity of the series employed using the gallant Lee and Strazicich (2003) two breaks LM test. The test assumes the existence of a break in both the null and alternative hypothesis. The test is break point nuisance invariant under both null and alternative hypothesis. The procedure is unaffected by neither size nor location distortion. This makes the test free from spurious rejection and unaffected by size and incorrect estimation irrespective of whether the structural break is present or not (Lee & Strazicich, 2003).

The LS test in table 1 indicates that all the series are found to be trend stationary at level at 5% and 1% under both crash and trend models with the exception of *LRER* under the trend model characterized by breaks in both level and trend. Therefore, the test established that the series are trend stationary at level.

Table 1: Lee and Strazicich Two-Break Minimum Lagrange Multiplier (LM) Unit Root Test

	Model A					Model C				
Variables	k	$\hat{T}_B$	$\hat{t}_{\gamma j}$	*Test Statistic*	*Critical Value Break Points* λ	k	$\hat{T}_B$	$\hat{t}_{\gamma j}$	*Test Statistic*	*Critical Value Break Points* λ
INT	1	1992Q4	1.407	-3.872**	.01	1	1995Q2	-2.675***	-5.664**	-.03
		2003Q3	-2.000**		-.02		2005Q3	2.769***		.03
INFD	1	1992Q4	- .864	-5.921***	-.01	1	1994Q1	4.614***	-6.637***	.05
		1996Q4	.227		.01		1997Q2	-3.405***		-.04
OUTG	1	1992Q4	.896	-5.799***	.01	1	1994Q2	-3.624***	-6.125***	-.04
		1996Q1	.056		.00		1997Q2	2.615***		.03
LRER	1	1995Q1	-1.729*	-3.922**	-.02	1	1995Q1	3.262***	-4.788	.03
		2001Q1	-2.599**		-.03		2001Q1	-1.848*		-.02
LRMS	1	1992Q4	- .226	-5.379***	-.00	1	1994Q1	-4.358***	-6.429***	-.05
		1996Q4	- .044		-.00		1997Q2	4.648***		.05

Critical values	1%	5%	10%
Model A	-4.545	-3.842	-3.504
Model C	-5.823	-5.286	-4.989

Note: k is the optimal number of lagged first-difference terms included in the unit root test to correct for serial correlation. $\hat{T}_B$ denotes the estimated break points. $\hat{t}_{\gamma j}$ is the *t* value of DT_{jt}, for j=1,2. See J. Lee and Strazicich (2003) Table 2 for critical values. ***, ** and * indicates significance of the LM test statistics at 99%, 95% and 90% critical level, respectively. While ***, ** and * indicates the two-tailed significance level of the break date at 99%, 95% and 90% respectively.

Baseline forward-looking monetary policy rule result

The baseline forward-looking monetary policy rule described in equation 12 above is estimated based on the suggestions emphasizing the assessment of the expected future economic performance. The result of the equation 12 is presented in table two below:

Table 2: Baseline forward-looking monetary policy rule for Ghana

	κ	α	β	γ	ρ	J -Statistics
Pre-IT Adoption	0.4083 (0.3603)	4.8939*** (0.3857)	0.7933*** (0.1626)	2.8070** (1.2454)	0.4415*** (0.0876)	1.3668 (0.713)
Post-IT Adoption	5.9130*** (1.1458)	0.7527* (0.4172)	1.1404*** (0.0975)	0.7735 (0.6431)	0.3301** (0.1313)	0.7740 (0.679)
Full-Sample Period	0.09572 (0.8896)	3.1656*** (0.2648)	1.4212*** (0.2452)	1.7991 (1.1546)	0.6083*** (0.1128)	6.2250 (0.999)

***, ** & * represent 1%, 5% and 10% respectively. The values in parenthesis denote standard errors, while the parenthesis attached to J statistics shows the probability values. The set of instruments used in the pre-IT adoption and full sample period include three lags of interest rate, one lag of inflation, the output gap, exchange rate and real money supply. Whereas, two lags of interest rate and inflation deviation, one lag of the output gap and exchange rate were employed in the estimation of post-IT adoption period.

In the pre-IT adoption period, despite the rise in the nominal interest rate by the Bank of Ghana, but the increase was not sufficient enough to rise the real rate. Impliedly, the increase was not enough to lower aggregate demand in order to bring inflation back to its equilibrium level in the economy. However, the result in the post-IT adoption indicates that the real interest rate responds to the rise in the nominal rate which succeed in cutting the aggregate demand and inflation to its target rate. Furthermore, the full sample period also follow the trend of the post-IT adoption which depict the pursuance of true inflation targeting in the economy. The values of k and α in the second and third columns of table 2 represent the equilibrium nominal interest rate in the long run. The result of the β in the pre-IT adoption falls below one (0.793) indicating that prior to the adoption of IT the rise in the nominal rate of interest does not influence the real rate to restore inflation back to its appropriate required level. The significant positive and greater than one values of $\beta > 1$ in the post-IT adoption and full sample period 1.404 and 1.4212 respectively indicate that the Bank of Ghana has performed the role of nominal anchor for the economy through the mechanism of inflation targeting. The coefficients of the output gap also carry the expected magnitude and sign $\gamma > 0$ which further confirm the rule. However, the non-significance of the coefficients in the post-adoption and full sample periods reveal a further indication for the full pledge adoption of the IT framework in the Ghanaian economy[1]. A similar result was obtained by Torres (2003) in the Mexico after 1996 where output gap coefficients were found to be lower than that of inflation deviation.

The moment condition of over-identification is assessed using an objective function via Sergen statistics (*J*-statistics). Hence, the model is evaluated using the *J*-statistics with a null hypothesis that the over-identifying restriction is fulfilled. The model is not rejected at any level of significance which shows that the GMM estimator is asymptotically normally distributed and consistent (Hansen & Singleton, 1982). The instruments employed in the estimation are expected to contain the necessary information at the time of setting the rate of interest by the authorities and anticipated to be vital in determining the output gap and inflation deviation[2]. This result is further confirm using the augmented forward-looking policy rule specified in equation 17.

Augmented forward-looking monetary policy rule result

Table 3 below depict the estimates of the augmented forward-looking policy rule version. The rule as indicated in equation 17 accommodates the influence of other variables such as the real exchange rate and real money supply in determining the equilibrium interest rate. The statistical significance of the variables in all the cases (pre-IT, post-IT adoption and full sample period) indicate the independence of the each variable augmented in the model. The fact that including the additional variables do not alter the expected signs and magnitude of the baseline result; it is an indication that none of the variables is correlated with the output gap and inflation deviation. Therefore, the information obtained in the real exchange rate and real money supply is independent and not corporated into expected inflation and output gaps in the economy. The following combination (expected inflation deviation, output gap, real money supply and real exchange rate) portray the approximation of the mechanism through which the Bank of Ghana can determine its monetary instrument (interest rate).

[1] As a further check for validity, a similar result is obtained when expected rate of interest is used to estimate the baseline forward-looking monetary policy rule for Ghana. The result is available on request.

[2] Numerous lag lengths for different instruments were estimated. The result reported in table 2 shows the appropriate lags that certify the requirements of the model adequacy and adequately take part in forecasting output and inflation gaps which aid in adjusting the policy rule in Ghana.

Table 3: Augmented forward-looking monetary policy rule for Ghana

	κ	α	β	γ	ρ	$\phi 1$	$\phi 2$	J -Statistics
Ghana								
Pre-IT Adoption	0.1124	1.1423***	0.3041***	0.4651***	0.4794***	1.8241***	0.5292**	5.8568(0.119)
	(0.0161)	(0.0947)	(0.0512)	(0.7365)	(0.0689)	(0.3878)	(0.2273)	
Post-IT Adoption	0.0000012	1.2073***	2.4639***	0.3395***	0.7695***	1.9109***	3.2322***	0.0005(0.998)
	(0.000025)	(0.0057)	(0.0013)	(0.0011)	(0.0048)	(0.0298)	(0.0102)	
Full Sample Period	0.0067	0.8186***	2.0914***	0.3356	0.8050***	2.2694***	0.6009***	1.5813(0.209)
	(0.0126)	(0.1090)	(0.3301)	(0.5499)	(0.1251)	(0.4808)	(0.3484)	

***, ** & * represent 1%, 5% and 10% respectively. The values in parenthesis denote standard errors, while the parenthesis attached to J statistics shows the probability values. The set of instruments used in the pre-IT adoption estimation includes, two lags of interest rate, the inflation target, exchange rate and one lag of inflation and the output gap. The post-IT adoption employed three lags of interest rate, two lags of the inflation target and exchange rate, one lag of the output gap and real money supply. Meanwhile, the instruments used in the full sample comprise two lags of output gap and exchange rate and one lag of interest rate, inflation, and real money supply.

The result from the augmented rule in table 3 also indicates that although the augmented variables are significant and different from zero but the coefficients β and γ do not follow the IT framework in the period prior to the adoption of the rule. The findings in both post IT and full sample period report a significant and positive none zero parameters for the real exchange rate and real money supply; meaning that any increase in these variables in Ghana can be restore by a sufficient rise in the nominal interest rate which stimulate the real rate. The parameters β and γ are found positive above one and zero respectively and significant for β (row two, column four and row three, column five of table 3) above. This result further supports the nominal anchor hypothesis and adoption of the full-fledged inflation targeting in the country as in the baseline case. The finding is in line with Taylor principle, Torres (2003) in Mexico and Clarida, et al. (2001) in the United States among others.

7. Conclusion

The study examines how Ghanaian monetary authority determines its policy instrument in the economy and whether inflation targeting has performed the role of the nominal anchor in the economy. The result generally indicates that the monetary policy in Ghana is characterized as a forward-looking inflation targeting principle in which the parameter of the inflation deviation is significant and greater than one in both cases and that of output gap is positive and greater than zero although not significant in most cases. The deduction from the result is that, when monetary authority increases the nominal interest rate the real rate will respond sufficiently in response to the expected inflation in the economy.

The result confirms that Ghanaian economy practice full-fledged IT framework immediately after the adoption of IT in the economy. Evidence from the result also indicates that the monetary policy rule also serve as a nominal anchor of the economy. In the alternative policy rule, the Ghanaian interest rate under the augmented monetary policy rule could be determine by the real exchange rate and real money supply in addition to the baseline variables of inflation deviation from its target and output gap. It indicates how the domestic economic performance of Ghana relates to monetary policy rate, although, real exchange rate is an asset price which relates to the strength of the domestic currency in relation to the basket of foreign currencies. The paper recommends that the monetary authority should further strengthen the IT framework adopted in the economy in order to continue keeping inflation to the required single digit target.

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