Inflation Targeting and Monetary Policy in Ghana

Abstract

An inflation-targeting regime has been in place in Ghana since 2007, but the inflation rate has remained persistently high. During the 2007-2017 period, inflation exceeded the announced target by four percentage points on average, despite the target never falling below a relatively unambitious 8% per annum. We investigate whether the poor conduct of monetary policy is responsible for this outcome, and find that it is not. Monetary policy reaction functions are similar to those estimated for countries with successful monetary policies, and interest rates respond in the theoretically recommended way to inflation shocks.

Keywords: expectations; inflation targeting; interest rates.

JELcodes: E52; E58

1 Introduction

Since the adoption of formal inflation targets (IT) by New Zealand in 1990, the framework has become popular for the conduct of monetary policy in many countries.[1] Evidence from previous studies shows that inflation targeting has generally been successful in reducing the inflation level, particularly in non-advanced economies (De Mendonça and De Guimarães e Souza, 2012; Gonçalves and Salles, 2008; Lin and Ye, 2009; Mishkin and Schmidt-Hebbel, 2007; Samarina *et al.*, 2014; see Walsh, 2009, for a useful survey). However, Ghana is one country where initially high inflation has persisted in double figures after the adoption of inflation targeting, and stayed far above relatively unambitious targets.[2] The Bank of Ghana was granted operational independence by the Bank of Ghana Act of 2002, and formally adopted inflation targeting in May 2007. The inflation target has generally been slightly below 10% p.a., except for a brief period in 2008-09 when the target was relaxed to allow for rapid imported food price inflation, whereas the actual inflation rate since 2007 has averaged over 13% p.a., with no sign of any downward trend, so the gap between actual and target inflation has been persistently substantial. Even though the inflation-targeting regime in Ghana may have been an improvement on previous monetary policy, the fact remains that high inflation has persisted well above the target during the inflation-targeting period.

In this paper we investigate whether this occurred because monetary policy has not been conducted in the theoretically recommended manner. Theory indicates that, for monetary policy to control inflation successfully, positive inflation shocks must be met by policy measures to

[1] We define inflation targeting (IT) as a conduct of monetary policy where a central bank (1) has price stability as its primary objective, (2) publicly announces a medium-term numerical target inflation and commits to it, and (3) uses the inflation forecast as an intermediate target.

[2] In terms of IT adoption in Africa, Ghana was followed by Uganda in 2011.

reduce aggregate demand, which in standard models requires a rise in real interest rates, and therefore a rise in nominal interest rates that is greater than the inflation shock (e.g. Svensson, 1997). In countries where inflation has been successfully controlled, with or without formal inflation targets, estimated monetary policy reaction functions generally conform to this rule in the long run, although the adjustment of interest rates tends to be gradual (Clarida et al., 1998, 2000; Gorter et al., 2008). The press statements of the meetings of the Monetary Policy Committee (MPC) of the Bank of Ghana indicate that various measures of inflation, including expectations of business leaders derived from surveys, are taken into account in the setting of interest rates, as theory recommends, and our econometric results confirm this. We show, by estimating various alternative specifications of a monetary policy reaction function for Ghana, that the response of interest rates to inflation shocks has been similar in the long run to that in countries that are regarded as having been successful in controlling inflation, even if the short-run reaction might be towards the weak end of the spectrum. Thus, the indication is that monetary policy may not be responsible for the persistently high inflation in the inflation-targeting period. Although there has been some similar work on emerging markets (e.g. Muñoz Torres and Shepherd, 2014, for Mexico), we know of no previous work of this kind for Ghana, or more generally for Africa in the formal inflation-targeting period.[3]

2 Background

Figure 1 shows a graph of monetary policy rates (MPR, the key interest rate set by the Monetary Policy Committee of the Bank of Ghana), the 12-month inflation rate and the announced inflation target in Ghana since 2002. From mid-2010 to late-2012 inflation fell to slightly below 10%, and

[3] Although Bawumia et al. (2008) estimate monetary policy rules for Ghana, they used data from November 2002 to May 2008, largely covering the period in which IT was not formally adopted in Ghana.

was very close to the target. From 2013 to 2015, however, inflation steadily increased, although it then declined from 2016 onwards. On average inflation has exceeded the target by a substantial margin (4.0 percentage points, since the official adoption of inflation target in May 2007), despite the fact that the target has been relatively unambitious by international standards. A notable feature is that since 2010 real interest rates, approximated by the difference between MPR minus overall inflation, have been consistently positive, which was not true in the earlier period. Next, Figure 2 shows how recent inflation in Ghana compares with that in other inflation-targeting countries. Ghana's inflation exceeds that in the second-highest IT country by a large margin over both five-year periods (2007-11 and 2012-16). In most countries the IT regime has kept inflation much lower than in Ghana.

Figure 1: The Policy Interest Rate, Inflation and Inflation Targets

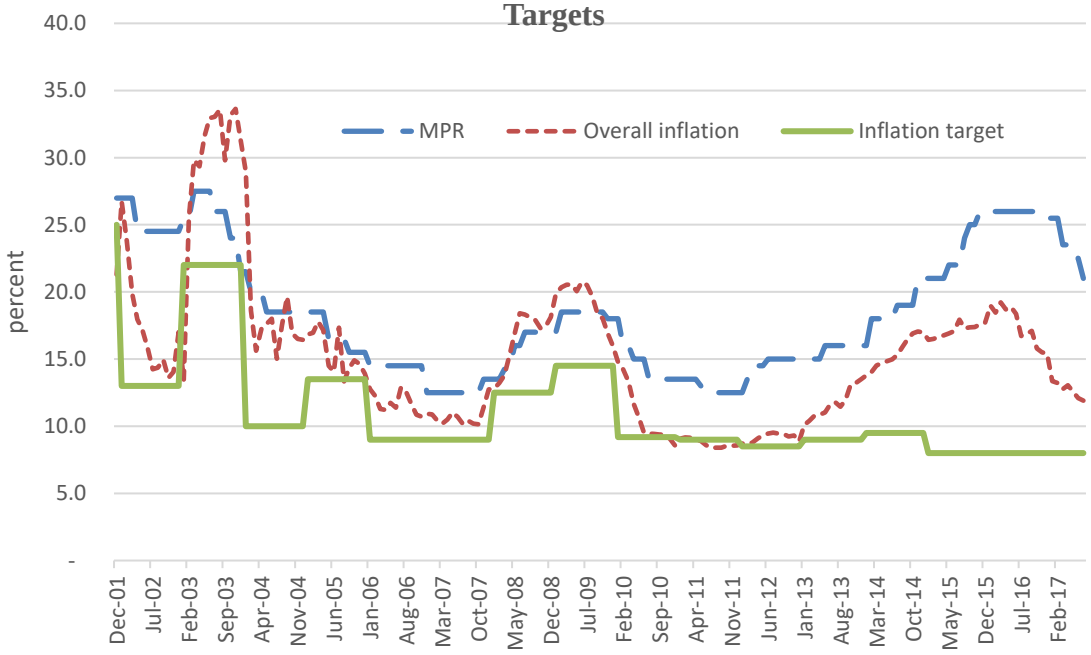
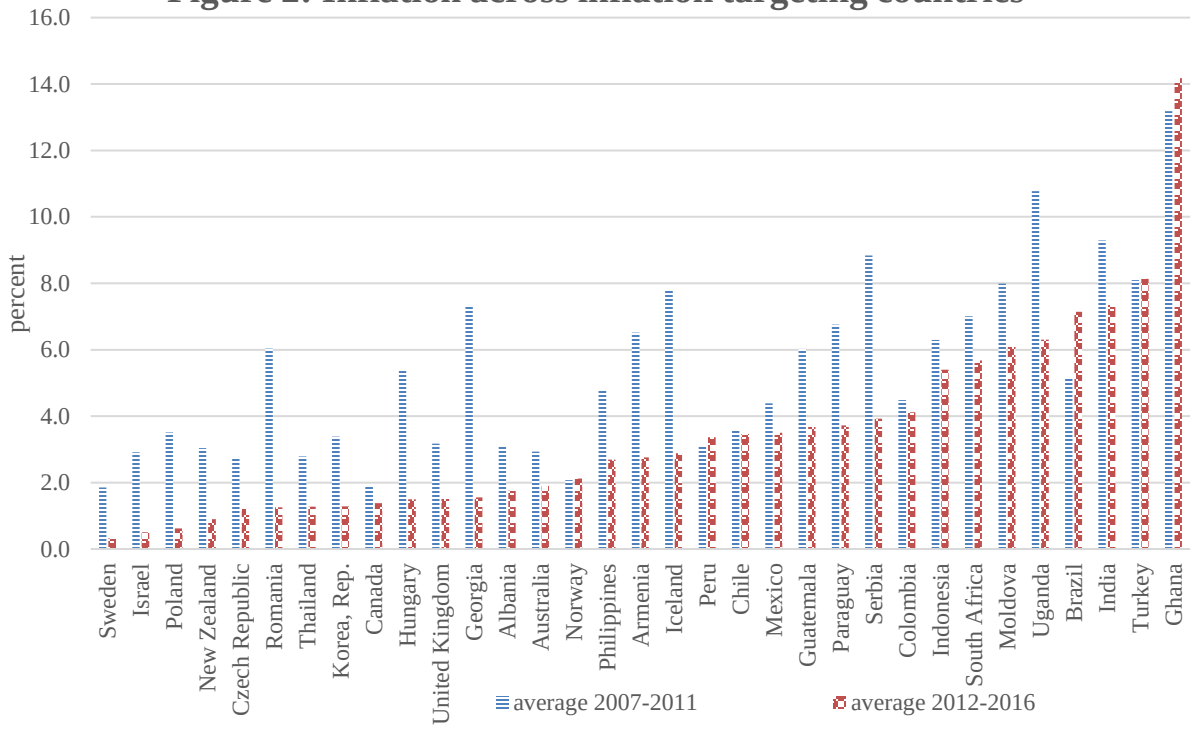


Figure 2: Inflation across inflation targeting countries



Source: World Development Indicators, World Bank

Regarding the practicalities of monetary policy conduct in Ghana, the Monetary Policy Committee of the Bank of Ghana, which consists of seven members chaired by the Governor of the Bank, meets bi-monthly to decide whether or not to adjust interest rates. The MPC typically meets over a two-day period, followed by a press conference on the third day at which a press statement about the decision and general developments is released.[4] The meeting dates for each year are announced in advance. Decisions are made by a vote of the Committee on a one-person one-vote basis, with each member required to clearly articulate in the meeting why their decision should be the preferred option, but disagreements are not reported and decisions are presented as unanimous in the press statement. In general, policies are tightened when the Committee observes that the upside risks to inflation outweigh the downside risks. Conversely, the Committee loosens monetary policy if downside risks to inflation or poor output performance dominate.

To give a flavour of the discussions, Table 1 lists the monetary policy decisions between February 2015 and July 2017, and shows the considerations that were highlighted in the press statements to those meetings. Economic factors such as trends in inflation, the exchange rate, growth, the fiscal position and commodity prices all feature regularly, suggesting that in the context of interest rate rules (estimated below) it is relevant to consider the role of these factors. In particular, while inflation is repeatedly mentioned in the statements, the Bank often highlights the components of overall inflation, such as core inflation (headline inflation excluding energy and utilities) and food inflation.[5] Further, it is clear that expected future inflation (not only current inflation) is critical in monetary policy decisions.[6] Acknowledging these, the following analysis

[4] The press release is immediately posted on the Bank's website while the transcript of the press conference and more detailed monetary policy and financial stability reports are published later.
[5] For example, among the fifteen decisions in the table, core inflation is mentioned in seven decisions.
[6] In the table, inflation expectations appear in seven decisions.

on monetary policy reaction functions takes account of the components of inflation, as well as inflation expectations.

Table 1: Recent Bank of Ghana Monetary Policy Decisions

Decision date	Decision	Current MPR (%)	Reason(s) for decision
Feb. 18, 2015	No change	21.0	*1. Uncertainty in global environment and volatilities in the financial markets; 2. Lower international commodity prices; 3. Pickup in economic activity in Q4; 4. Improved business and consumer sentiments; 5. Lingering energy sector challenges; 6. IMF deal expected to boost investor confidence; 7. Rise in food inflation ahead of the lean season; 8. Rising core inflation*.*
May 13, 2015	+1%	22.0	*1. Elevated inflation and inflation expectations; 2. Significant exchange rate pass-through, 3. Upward adjustment in energy and utility prices; 4. Core inflation rising; 5. Challenges in the energy sector, fiscal consolidation, depreciation of the currency weighing down on economic activity; 6. Business sentiments softened but consumer confidence rose; 7. Volatile commodity prices*
July 15, 2015	+2%	24.0	*1. Headline and core inflation continued to rise since the last MPC meeting; 2. Still elevated inflation expectations; 3. Local currency recovered strongly against the major currencies in July 2015; 4. Fiscal consolidation; 5. Vulnerable domestic growth conditions and the impact of the energy crisis; 6. Volatile commodity prices and weak global growth prospects;*
Sept. 14, 2015	+1%	25.0	*1. Persisting inflation pressures; 2. Elevated inflation expectations; 3. Core inflation rising; 4. Significant uncertainty in the domestic FX market; 5. Slower pace of growth; 6. Fiscal consolidation; 7. Adverse effects of elevated volatility in financial markets, uncertainty as to the timing and impact of expected tightening in the Fed's monetary policy and declining commodity prices on the balance of payments and in turn the inflation outlook.*
Nov. 16, 2015	+1%	26.0	*Moderate increase in inflation; inflation expectations far above the medium term target; Core inflation rising; Worsening external financial conditions; Expected increase in utility tariffs; Need to reinforce the relative stability in the FX market; Slower economic activity and growth but expected improve with improvement in energy situation; Fiscal policy within the programme target; Declining commodity prices; High upside risks to the inflation, with a likelihood of a further drift away from the medium term target*

Jan. 25, 2016	No change	26.0	*1. Core inflation rising; 2. Slower pace of growth though expected to rebound with improvement energy situation; 3. Tight monetary and fiscal policy stance; 4. Weak consumer confidence; 5. Weak commodity prices and a slack in global growth; 6. Relatively stable exchange rate*
Mar. 21, 2016	No change	26.0	*1. Improvement in the pace of economic activity; 2. Positive consumer and business sentiments; 3. Improvement in energy situation; 4. Increased oil and gas production; 5. Fiscal consolidation; 6. Uncertainties regarding crude oil prices may pose significant risks; 7. Significant volatilities in the commodities and financial markets and tight external financing conditions; 8. Relative stability in the forex market; 9. Risks to inflation and growth outlook balanced.*
May 16, 2016	No change	26.0	*1. Broadly positive growth outlook; 2. Faster pace of consolidation; 3. Subdued global growth outlook and tightening financing conditions; 4. Exchange rate stability; 5. Risks to inflation and growth as balanced*
Jul. 18, 2016	No change	26.0	*1. Low commodity prices; 2. Relative stability of the local currency and expected improvement in liquidity on the foreign exchange market; 3. Risks to inflation and growth as balanced*
Sept. 19, 2016	No change	26.0	*Moderation in headline inflation but high still high relative to the medium term target. 2. Stable exchange rate; 3. Expected tighter fiscal consolidation; Lower growth,*
Nov. 21, 2016	-0.5%	25.5	*1. Global economy remains fragile with uncertainties; 2. Inflation and underlying inflation declining; 3. Exchange rate stable weak and below trend growth conditions; 4. Declining commodity prices and disruptions in oil and gas production; 5. Fiscal consolidation efforts.*
Jan. 23, 2017	No change	25.5	*1.* Declining headline, core inflation and inflation expectations; 2. Sharp exchange rate depreciation and its expected impact on inflation; 3. Persistent increases in food inflation and 4. Fiscal slippage of the previous year. 5. Modest growth conditions but with positive prospects; 6. Uncertainties in the global environment.
Mar. 27, 2017	-2%	23.5	*1.* Underlying inflation pressures have eased considerably; 2. Growth is likely to remain significantly below potential
May 22, 2017	-1%	22.5	*1. Economic activity picked up but still below potential; 2. Improved business sentiments and easing credit stance; 3. Increased oil production; 4. Expected fiscal consolidation; 5. Headline inflation and inflation expectations trending downwards and exchange rate is stable. Downside risks to growth outweigh the upside risks to inflation in the outlook*
Jul. 18, 2017	-1.5%	21.0	*1. Improving economic activity and fiscal policy measures in budget expected to provide further impetus to growth; 2. Inflation declining with stability of the exchange rate expected to reinforce price stability; 3. Low inflation expectations.*

Source: Bank of Ghana. *Core inflation is CPI inflation excluding energy and utility prices

3 Empirical methodology

To investigate if the conduct of monetary policy has been responsible for the persistently high inflation under inflation targeting in Ghana, we estimate various forms of central bank reaction functions. The estimation of central bank reaction functions began with Taylor (1993, 1999) and was further developed by Clarida *et al*. (1998, 2000), amongst others. The basic idea is that the central bank sets the policy interest rate (i_t) in reaction to deviations of inflation (π_t) from its target rate (π_t^*), and some measure of the output gap (y_t).[7] Since in practice interest rates tend to be adjusted somewhat gradually, a distinction is made between the actual interest rate and the target rate (i_t^*). The target rate is assumed to be determined as follows:

$$i_t^* = \alpha_\pi(\pi_t - \pi_t^*) + \alpha_y y_t \qquad (1)$$

Equation (1) shows that the target rate changes in response to the inflation and output gaps. The positive parameters α_π and α_y respectively measure the weight that the central bank places on the deviations of inflation from its target and output from its potential. Theory suggests that the response to the inflation deviation (α_π) should be greater than one, because what matters to aggregate demand (consumption and investment) is the real, not nominal, interest rate. That is, when inflation increases, the central bank, if it wants to lower aggregate demand and output, needs to raise the real interest rate.

The actual interest rate tends to adjust gradually in all countries, and is assumed to be a weighted average of its lagged rate and the target rate:

$$i_t = (1 - \rho)i_t^* + \rho i_{t-1} + \varepsilon_t \qquad (2)$$

[7] An early work of Corbo et al. (2001) estimate a simple Taylor rule for a number of inflation targeters and non-targeters for the 1990-1999 period.

where $0 < 1 - \rho \leq 1$ represents the speed of adjustment. Substituting (1) into (2) and subtracting the lagged interest rate from both sides yields:

$$\Delta i_t = (1-\rho)\alpha_\pi(\pi_t - \pi_t^*) + (1-\rho)\alpha_y y_t - (1-\rho)i_{t-1} + \varepsilon_t \qquad (3)$$

When equation (3) is estimated, the inflation coefficient is just the short-run response, which is a combination of the adjustment speed, $1-\rho$ and the long-run response of the target rate to inflation, α_π. In particular, where the adjustment speed is slow, the short-run coefficient will be many times smaller than the implied long-run effect (see Clarida *et al*., 1998, for example).[8]

As pointed out by many studies (for instance Clarida *et al.* 1998, 2000; Dolado *et al.* 2000; Gorter *et al.* 2008), in the presence of sizeable lags and uncertainty about the transmission mechanism of monetary policy, it is appropriate to allow nominal interest rates to react not only to the current but also to expected future deviations of inflation from its target and output from their long-run potential. As seen in Table 1, it appears that the Bank of Ghana's monetary policy decisions are closely linked to inflation expectations in particular. Thus, the estimated equation becomes:

$$\Delta i_t = (1-\rho)\alpha_\pi(E_{t-1}\pi_{t+k} - \pi_t^*) + (1-\rho)\alpha_y y_t - (1-\rho)i_{t-1} + \varepsilon_t \qquad (4)$$

where E denotes the expectation operator, and the subscript *t-1* indicates that expectations are based on the information set available in period *t-1*.[9] In equation (4), the investigator has to make a choice about how to measure inflation expectations. For example, they could be derived from surveys of consumers and firms, or from the central bank's own forecasts. In Ghana, the central

[8] Below, we discuss the Central Bank of Ghana's interest rate smoothing behaviour in comparison with other central banks.

[9] The reason why expectations are based on information set in period t-1, rather than period t, is explained below. However, in short, it is to clarify that expectations are formed (by business establishments) before each round of Monetary Policy Committee meeting so that the information set does not contain current policy responses.

bank conducts a regular survey of business expectations, as described below, and that is the measure used here.

Other variables might also be included in monetary policy reaction functions. In the case of Ghana, we add the lagged change in the policy rate as well as its level, and we also include the rate of depreciation of the bilateral exchange rate against the US dollar (X).[10] The former is to account for the persistence in the change in the policy rate, and the latter is to account for a change in import prices in domestic currency. Then, equation (3) (based on current inflation) becomes:

$$\Delta i_t = \beta(\pi_t - \pi_t^*) + \gamma y_t + \varphi i_{t-1} + \delta \Delta i_{t-1} + \psi \Delta X_{t-1} + \varepsilon_t \qquad (5)$$

where coefficients, β, γ and φ are a composite of parameters (see above). All the coefficients except for φ are expected to be positive. Likewise, equation (4) (using inflation expectations) becomes:

$$\Delta i_t = \beta(E_{t-1}\pi_{t+k} - \pi_t^*) + \gamma y_t + \varphi i_{t-1} + \delta \Delta i_{t-1} + \psi \Delta X_{t-1} + \varepsilon_t \qquad (6)$$

When we estimate equations (5) and (6), the dependent variable may be treated as a continuous variable, or as a discrete variable with three possible values (increase, no change or decrease).[11] In the case where the dependent variable is discrete, the equation is testing only whether the interest rate is moved in a certain direction in response to the independent variables, and it provides no estimate of the magnitude of that response. We provide estimates for both specifications. Further, motivated by the stated reasons for actual monetary policy decisions made by the Bank of Ghana (Table 1), for equation (5), we consider not only headline current inflation but also components of inflation (core, food, and non-food inflation). Since the target inflation rate

[10] We use the exchange rate date from the previous month, thereby ΔX_{t-1} in equation (5). As explained below, this is to allow for the fact that the exchange rate may react to the interest rate decision after the meeting.
[11] A number of studies, including the recent study of Muñoz Torres and Shepherd (2014), use limited dependent variable techniques to model interest rate setting.

is announced and varies over time, we use the difference between the actual (or expected) and target inflation rates as a regressor.

4 Data

The data used in this study are sourced mainly from the Bank of Ghana (BoG), and run from November 2002, when the Bank was granted operational independence, up to the 76th MPC meeting in May 2017. In most regressions only data from the formal adoption of inflation targeting in May 2007 are used.

An observation in the regression analysis is a meeting of the MPC at which an interest rate decision was taken. The MPC's meetings are typically bi-monthly, and usually in the third week of the month. The interest rate we use is the monetary policy rate (MPR) – the key interest rate set by the MPC at the meetings. These data are mainly sourced from BoG's website or where necessary, from the Ghana Statistical Service website. For the ordered logit and probit regressions, the data are coded as follows: 1 for a cut in interest rates, 2 for no change and 3 for an increase. Inflation is the 12-month rate of increase in the consumer price index taken from the Ghana statistical service. We also use the food and non-food components of the index separately as well as core inflation (defined as headline inflation excluding energy and utilities, for which the prices are set by the government). Our main purpose here is to test if greater weight is placed on the more persistent elements of inflation, which is non-food inflation (as shown below).

As an alternative to actual inflation, we use inflation expectations from the business confidence survey conducted by the Bank before each round of MPC meetings. The sample consists of "key" business establishments across the country. The inflation expectations are derived from the question **"***What is your expectation about the rate of inflation by the end of the*

current calendar year? (Please tick one only)", the options being: 1-9%, 10-15%, 16-20%, 21-25% and 26-30%. We focus on the mid-points of the options provided (that is 5, 12.5, 18, 23 and 28%), and use the weighted average of the business expectations of inflation for the period. For example, if in June 2017 the responses were respectively: 21.6% of the respondents chose the range 1-9%, 66.7% the 10-15% range, 8.8% the 16-20% range, 2.0% the 21-25% range and 1.0% the 26-30% range, the derived inflation expectation for that period will be 11.73%. The index so computed is then compared to the inflation target to derive the expected inflation gap.[12] The process is repeated for every MPC meeting in the course of a particular year. Since the survey question always asks about inflation at the end of the calendar year, rather than a fixed number of months in the future, there is implicitly a gradual shortening of the horizon between the first and final surveys for the year.[13] We have tested whether this shortening of the horizon in the course of the year makes a difference to the results, and have found that it does not.[14]

Output is proxied by the Bank of Ghana Composite Index of Economic Activity (CIEA), a monthly index that measures the level of economic activity. We compute the output gap as a deviation of the Hodrick-Prescott (HP) trend from the actual index. The exchange rate data used are the monthly changes in the nominal Ghana cedi against the US dollar reported by the Bank, with an increase indicating a depreciation of the Ghana cedi. To allow for the fact that the exchange rate may react to the interest rate decision after the meeting, we use the exchange rate data from the previous month. There is less scope for the adjustment of prices and output after the

[12] Note that in recent times, the Bank also derives consumer and financial sector inflation expectations but the series for these do not go far back enough.

[13] In the context of equations (4) and (6), this means that the subscript for the future inflation rate, *k*, becomes smaller over months towards the end of the calendar year.

[14] Specifically, we have tested whether the inflation expectations coefficient has a seasonal pattern that reflects this shortening of the horizon, and have found that it does not.

meeting, so for the output gap we use the current month values, and for inflation we use the average of the current and previous month's 12-month inflation rate.[15]

Table 2 provides summary statistics of the variables for the inflation-targeting period (May 2007 – May 2017). As can be seen from Table 2, interest rates have typically been high in Ghana, with the central bank key interest rate, the monetary policy rate, ranging between 12.5 and 26.0 percent. Inflation averaged 13.6 percent, exceeding the target for the period on average by 4.0 percentage points. Expected inflation, as reflected in the survey of business, averaged 14.5 percent, even further above the target than actual inflation, which seems to suggest that the Bank has not yet managed to anchor inflation expectation properly.

As Table 2 shows, so far the MPC has made 52 policy rate decisions since the formal adoption of inflation targeting in May 2007, more than half of which (31 meetings) were to leave interest rates unchanged. On 23.1 percent of the occasions (12 meetings), the decision was to raise the policy rate, and on 17.3 percent of the occasions (9 meetings), the policy rate was cut. Movements in either direction were between 0.5 and 2.0 percentage points.

[15] We have also estimated the model with lagged output and inflation, with similar results.

Table 2: Descriptive Statistics, 2007(05) - 2017(05)

Variable	*Mean or sample (%)*	*sd*	*min*	*max*
Policy rate	17.8	4.6	12.5	26.0
Changes	0.1	0.8	-2.0	2.0
Distribution of MPR changes				
No change	59.6 (%)			
Increase by:	23.1 (%)			
0.5	1.9 (%)			
0.75	1.9 (%)			
1	13.5 (%)			
1.75	1.9 (%)			
2	3.9 (%)			
Decrease by:	17.3 (%)			
-0.5	7.6 (%)			
-1	3.9 (%)			
-1.5	1.9 (%)			
-2	3.9 (%)			
Increase/Decrease	40.4 (%)			
Inflation				
Actual	13.6	3.9	8.4	20.5
actual_food	8.2	3.8	3.2	19.4
actual_non-food	17.2	5.0	10.7	25.7
Target	9.6	2.0	8.0	14.5
gap†	4.0	3.6	-0.6	11.2
expected (businesses)ɧ	14.5	3.0	9.5	20.6
gap_expected‡	4.9	2.8	0.7	10.0
CIEA‼				
real index	328.1	81.5	187.7	463.6
output gap	0.9	13.2	-26.2	23.7
Exch. rate (Ghana cedis per USD)	2.2	1.1	0.9	4.3
depreciation against USD (log diff)	0.03	0.05	-0.1	0.2
fiscal balance	-7.3	2.3	-11.5	-4.0
Observations	52			

Notes: Inflation gap is the difference between actual and target inflation. ɧ: Inflation expectations of key business establishments across the country conducted and reported by BoG. ‡: deviation of expected inflation from the target. ‼: Composite Index of Economic Activity.

The equations above assume that the variables are stationary. In fact, as Table A1 (Appendix A) shows, we cannot reject the null hypothesis of non-stationarity in the levels of interest rates, inflation, and exchange rates.[16] Still, we tend to concur with previous authors who, confronted with a similar result, have argued that the failure to reject the null is a consequence of the low power of the tests in small samples, and that on theoretical grounds one would expect the variables to be stationary (e.g. Gorter et al., 2008, p. 480). As an insurance against non-stationarity, however, we below estimate an error correction model that incorporates a test for cointegration (Table 9). If the variables turn out to be cointegrated and the long-run coefficients are similar to those obtained assuming stationarity, then our findings would appear to be robust to the potential non-stationarity of the variables.

There is a potential issue of endogeneity of the explanatory variables if they incorporate some information from after the meeting, because in this case current policy interventions may affect current explanatory variables. To clarify, however, this concern is largely alleviated in our context. This is because we have used data on the exchange rate only up to the end of the previous month, to ensure that this variable is predetermined, and therefore simultaneous-equation bias is mitigated. We do not think endogeneity is a concern when expectations of future inflation are used either (equation (6)), since the business establishments form expectations *before* each round of MPC meetings (hence in equation (6) the expectation operator is based on information set available in period *t-1*), and it can also be treated as a predetermined variable. The concern that an MPC decision causes a change in expectation is mitigated.[17,18]

[16] Output gap shows a mixed result depending on the unit root tests adopted (See Table A1).

[17] Of course, to the extent that a policy change is expected (e.g., through the Bank's pre-meeting communications), the endogeneity concern remains. We thus implicitly assume that the bias of this type is negligible.

[18] Further, estimation assumes a stable policy reaction function over the period. That is, it could be that the way in which expectations are formed changes, perhaps because of learning about the Bank's reaction to shocks. If the Bank recognizes this, it will also recognize that it might be appropriate to change the coefficient on inflationary expectations, which now convey different information. In other words, a shift in the Bank's policy reaction function could be

5 Empirical results

In this section, we present the estimation results of equations (5) and (6) using the interest rate decisions of the 52 MPC meetings from May 2007 to May 2017. Three different models are presented. Model 1 is a simple OLS estimation of equations (5) and (6) using the actual change in the interest rate as the dependent variable, whereas Models 2 and 3 respectively use ordered logit and ordered probit estimators, and the dependent variable is a categorical variable, coded according to the following ordering: 1 for decrease, 2 for no change and 3 for an increase. These discrete choice models have been used in some previous work (e.g. Muñoz Torres and Shepherd, 2014) and are useful for modeling the direction rather than the size of policy actions. However, since in the present context these models involve loss of information about the size of policy actions, we regard them as a form of robustness test.[19] Last, to investigate whether results are robust to the alternative assumption that the variables are non-stationary, we estimate an error correction model.

5.1 Baseline estimation

As a baseline, we estimate a model in which the independent variables are the current inflation gap (current minus target inflation), the output gap as in Taylor (1999), the depreciation rate of the Ghana cedi against the United States dollar, lagged policy rate changes and the lagged level of the policy rate (see equation (5)). Here, current inflation gap is calculated using the headline (overall) current inflation rate.

triggered by changes in how the private sector forms its expectations; our approach assumes that there is no instability of this type either.

[19] To clarify, the use of discrete choice models is justifiable particularly in the context where adjustments in the policy instrument occur in small steps, including the corto system in Mexican monetary policy (according to Muñoz Torres and Shepherd, 2014).

The results are shown in Table 3. In Model 1, where the dependent variable is the actual interest rate change, all the variables have the expected signs (apart from lagged depreciation), but they are not all statistically significant. The difference between 12-month actual inflation and the target has a positive coefficient that is significant at the 5% level, but in magnitude it is only 0.162, which implies that in the short run nominal interest rates rise by only 16% of the magnitude of any positive inflation shock, and therefore real interest rates fall. To obtain the estimated long-run reaction of interest rates to an inflation shock, however, we have to divide 0.162 by minus one times the coefficient of the lagged policy rate, which is -0.105, and this yields a long-run coefficient of 1.54. Since this comfortably exceeds one, the implication is that monetary policy in Ghana is consistent with theoretical prescriptions for achieving price stability. The output gap has a positive coefficient, being significant at the 10% level. Lagged exchange rate depreciation is not significant.

In the second and third columns of Table 4, results are presented for an ordered logit and an ordered probit, with the dependent variable taking only three possible values: decrease (one), no change (two) and increase (three). The coefficients are generally more statistically significant than for Model 1 (indeed all are significant at the 5% level apart from lagged exchange rate depreciation), which suggests that the model is better at explaining the direction than the magnitude of an interest rate change.

Table 3: Estimates of a monetary policy reaction function for Ghana (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: change in policy interest rate	***Continuous***	***1: decrease, 2: no change, 3: increase***	
Inflation less target (% p.a.) †	0.162**	0.494**	0.296**
	(2.27)	(2.43)	(2.54)
Output gap‡	6.102*	23.296**	12.727**
	(1.90)	(2.15)	(2.35)
Lagged depreciation against USD§	-0.132	-0.170	0.318
	(-0.05)	(-0.02)	(0.08)
Lagged policy rate (%)	-0.105*	-0.322**	-0.197**
	(-1.75)	(-2.05)	(-2.13)
Lagged policy rate change	0.111	1.255**	0.739**
	(0.91)	(1.96)	(2.09)
Constant	1.224		
	(1.43)		
cut1			
Constant		-3.466	-2.100
		(-1.40)	(-1.42)
cut2			
Constant		1.100	0.543
		(0.43)	(0.36)
Long-run inflation coefficient	*1.54*		
Adj R-squared	0.34		
Pseudo R-squared		0.31	0.31
Pseudolikelihood	-47.35	-34.26	-33.90
Observations	52	52	52

Notes: †Deviation of actual inflation from target rate. ‡Measured as deviation of log composite index of economic activity from potential derived from HP filter. §Monthly change in local currency units/$ (+depreciation/-appreciation). Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively. The long-run coefficient is the short-run coefficient divided by minus one times the lagged policy rate coefficient.

5.2 Results based on components of inflation

5.2.1 Core inflation

Table 4 provides estimates for the response to core (underlying) inflation, defined as headline inflation excluding energy and utilities, for which the prices are set by the government. As Table 1 indicates, core inflation is quite frequently mentioned by the bank in policy statements. Compared to Table 3, in the first column of Table 4 the inflation coefficient is slightly smaller (0.122 compared with 0.162) and the output gap coefficient larger (8.303 compared with 6.102). However, the coefficient of the lagged policy rate is also slightly smaller in the absolute value (-0.081 instead of -0.105), which means that the estimated long-run inflation coefficient of 0.122/0.081=1.51 is similar to that in Table 4. Discrete choice models (Models 2 and 3) give similar results to Table 3, confirming that the direction of policy decisions estimated using Model 1 is robust.

Table 4: Estimates based on core inflation (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: change in policy interest rate	***Continuous***	***1: decrease, 2: no change, 3: increase***	
Inflation (core) less target†	0.122**	0.537**	0.301**
	(2.05)	(2.46)	(2.41)
Output gap‡	8.303***	30.886***	17.303***
	(2.73)	(2.96)	(3.33)
Lagged depreciation against USD§	1.340	4.882	3.606
	(0.50)	(0.64)	(0.88)
Lagged policy rate (%)	-0.081	-0.374**	-0.210**
	(-1.56)	(-2.31)	(-2.23)
Lagged policy rate change	0.200**	1.522***	0.883***
	(2.08)	(2.70)	(2.78)
Constant	1.026		
	(1.34)		
cut1			
Constant		-4.062	-2.206
		(-1.64)	(-1.52)
cut2			
Constant		0.555	0.403
		(0.24)	(0.29)
Long-run core inflation coefficient	*1.51*		
Adj R-squared	0.29		
Pseudo R-squared		0.31	0.32
Pseudolikelihood	-49.19	-33.87	-33.76
Observations	52	52	52

Notes: †Deviation of core inflation from target rate. ‡Measured as deviation of log composite index of economic activity from potential derived from HP filter. §Monthly change in local currency units/$ (+depreciation/-appreciation). Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively. The long-run coefficient is the short-run coefficient divided by minus one times the lagged policy rate coefficient.

5.2.2 Food and non-food inflation

Next, we test if monetary policy responds differently to food and non-food price shocks. Food tends to have a large weight in the consumer price index in low-income countries, which may make food prices politically sensitive, but it does not follow that monetary policy should focus on them. Since food price shocks are likely to be temporary, non-food prices may be a better measure of underlying inflation trends which monetary policy should target. In other words, non-food price inflation is likely to be more persistent than food price inflation. Table 5 shows an autoregression for food price inflation and non-food price inflation including seasonal dummies, using monthly data, which demonstrates that this is the case. For food prices the lagged dependent variable has a coefficient very close to zero, but the adjusted R-squared is high at 0.87, which indicates a pronounced seasonal pattern (coefficients not shown). For non-food prices the lagged dependent variable has a coefficient of 0.153, which is significant at the 10% level, indicating some degree of persistence, but the adjusted R-squared is only 0.30, indicating a much smaller degree of seasonality, as expected.

Table 5. Persistence of food price and non-food price inflation

	Food prices	Non-food prices
Constant	0.010***	0.013***
	(6.45)	(7.32)
Lagged inflation	0.007	0.153*
	(0.08)	(1.70)
Sample size	121	121
Adj R-squared	0.87	0.30

Notes. The dependent variable is the change in the log of the price index. Data are monthly from May 2007 to May 2017. Dummies for each calendar month are also included in the regression. Figures in parentheses are robust *t*-statistics.

Table 6 provides results allowing for a different response to food and non-food inflation shocks. It can be seen that non-food prices always have a much larger coefficient than food prices; in Model 1 the long-run non-food inflation coefficient (1.10) is more than three times as great as the corresponding food inflation coefficient (0.31), and in Models 2 and 3 only non-food prices are significant. These results suggest that the MPC recognizes that current non-food price inflation is more likely to persist into the future than food price inflation.

Table 6: Response to food and non-food inflation (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: change in policy interest rate	***Continuous***	***1: decrease, 2: no change, 3: increase***	
Inflation_food less inflation target†	0.029	0.118	0.077
	(0.81)	(0.88)	(1.03)
Inflation_non-food less inflation target†	0.102**	0.281**	0.167**
	(2.14)	(2.18)	(2.23)
Output gap‡	6.688**	24.487**	13.371**
	(2.11)	(2.29)	(2.53)
Lagged depreciation against USD§	-0.395	-0.735	0.016
	(-0.15)	(-0.09)	(0.00)
Lagged policy rate (%)	-0.093	-0.266*	-0.163*
	(-1.66)	(-1.91)	(-1.95)
Lagged policy rate change	0.117	1.280**	0.759**
	(0.91)	(2.01)	(2.14)
Constant	0.936		
	(1.22)		
cut1			
Constant		-2.445	-1.495
		(-1.12)	(-1.14)
cut2			
Constant		2.091	1.125
		(0.92)	(0.83)
Long-run food inflation coefficient	*0.31*		
Long-run non-food inflation coefficient	*1.10*		
Adj R-squared	0.33		
Pseudo R-squared		0.30	0.31
Pseudolikelihood	-47.22	-34.48	-34.14
Observations	52	52	52

Notes: †Deviation of food or non-food inflation from target inflation. ‡Measured as deviation of log composite index of economic activity from potential derived from HP filter. §Monthly change in local currency units/$ (+depreciation/-appreciation). Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively. The long-run coefficient is the short-run coefficient divided by minus one times the lagged policy rate coefficient.

5.3 Results based on expected inflation

Following Gorter *et al.* (2008), we test if expected inflation as measured by the business survey plays an important role in the policy rate decisions of the Bank of Ghana (equation (6)). As in the preceding section, three models are estimated. Instead of actual inflation, we use the inflation expectations of the business sector constructed from a survey by the Bank.[20] For the output gap, we use the deviation of the CIEA from its Hodrick-Prescott trend as above.

The results are reported in Table 7. The short-run coefficient of the expected inflation gap is positive and highly significant in all models. In Model 1, the short-run expected inflation coefficient of 0.226 is some 40% greater than the 0.162 estimated for actual inflation in Table 3. With a lagged policy rate coefficient of -0.106, the estimated long-run coefficient is 0.226/0.106=2.13, substantially greater than for actual inflation in Table 3. This suggests that the Bank takes more notice of expected inflation than of historical 12-month inflation, in line with the frequent reference to inflation expectation in the press statements (Table 1). In Models 2 and 3, the expected inflation coefficient is more than twice as large in Table 7 as in Table 3. The output gap in Table 7 has similar coefficients to Table 3.

[20] Section 4 provides a comprehensive review of how this is computed.

Table 7: Estimates based on expected inflation (2007:05 - 2017:05)

Model	*OLS*	*Ordered logit*	*Ordered probit*
	Model 1	Model 2	Model 3
Dependent variable: change in policy interest rate	***Continuous***	***1: decrease, 2: no change, 3: increase***	
Inflation expectations less target†	0.226***	1.127***	0.621***
	(3.09)	(3.13)	(3.40)
Output gap‡	5.764**	23.118**	11.949**
	(2.06)	(2.06)	(2.16)
Lagged depreciation against USD§	-1.159	-7.201	-2.517
	(-0.37)	(-0.68)	(-0.48)
Lagged policy rate (%)	-0.106**	-0.556***	-0.312***
	(-2.52)	(-3.05)	(-3.28)
Lagged policy rate change	0.043	0.851	0.509
	(0.37)	(1.26)	(1.40)
Constant	0.834		
	(1.63)		
cut1			
Constant		-5.474**	-3.040**
		(-2.20)	(-2.25)
cut2			
Constant		-0.134	-0.032
		(-0.06)	(-0.02)
Long-run inflation expectations coefficient	*2.13*		
Adj R-squared	0.39		
Pseudo R-squared		0.40	0.40
Pseudolikelihood	-45.45	-29.77	-29.74
Observations	52	52	52

Notes: †Deviation of expected inflation from target rate. ‡Measured as deviation of log composite index of economic activity from potential derived from HP filter. §Monthly change in local currency units/$ (+depreciation/-appreciation). Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively. The long-run coefficient is the short-run coefficient divided by minus one times the lagged policy rate coefficient.

5.4 Assuming non-stationarity

Our presumption is that variables are stationary. However, if the variables are truly non-stationary, then it is appropriate to estimate an error-correction model of the form:

$$\Delta i_t = \alpha + \beta \Delta i_{t-1} - \gamma[i_{t-1} - \delta(\pi_{t-1} - \pi_t^*) - \theta y_{t-1}] + \varepsilon_t \qquad (7)$$

Here δ and θ are the implicit long-run coefficients for the inflation and output gaps respectively. Equation (7) is estimated for actual inflation (Model 1) and survey data on inflation expectations (Model 2). If statistically significant, first differences of the independent variables are included. Table 8 shows the results. In each case the null of no cointegration is comfortably rejected at the 1% level.[21] The implicit value of the long-run coefficient for the inflation gap (δ), which is minus one times the ratio of the coefficient of lagged inflation to the coefficient of the lagged policy rate, is 1.17 for actual inflation (0.19/0.162) and 1.72 for the expectations of inflation from the business survey (0.376/0.219). The output coefficient is never statistically significant. Thus the error-correction confirms our previous results: that the policy rate seems to react more strongly to expected than to actual inflation, and that the coefficient is in the theoretically recommended range, i.e. it is greater than one. This robustness check thus provides some reassurance that our key results still hold even when the variables are actually I(1).

[21] In each case, F-statistic is larger than the I(1) critical value bound for significance level of 1% (5.61).

Table 8: Error correction model (2007:05- 2017:05)

Model	*OLS*	*OLS*
	Model 1	Model 2
Dependent variable: change in policy interest rate		
Lagged change in policy rate	-0.887***	-1.15***
	(-5.71)	(-7.67)
Lagged change in expected inflation less target (% p.a.) §		0.135**
		(2.05)
Lagged policy rate (%)	-0.162***	-0.219***
	(-3.14)	(-5.34)
Lagged inflation less target (% p.a.) †	0.190***	
	(2.97)	
Lagged expected inflation less target (% p.a.) §		0.376***
		(5.42)
Lagged output gap‡	1.53	0.626
	(0.59)	(0.28)
Constant	2.11***	2.08***
	(3.04)	(4.43)
Implied long-run inflation coefficient	*1.17*	*1.72*
Cointegration F-statistic (1% critical value = 5.61)	9.22***	16.42***
Adj R-squared	0.392	0.549
Observations	52	52

Notes: †Deviation of actual inflation from target rate. ‡Measured as deviation of log composite index of economic activity from potential derived from HP filter. § Expected inflation as derived from business surveys. Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively.

6 Discussion

Having estimated variants of monetary policy reaction functions for Ghana under formal inflation targeting (2007-2017), our conclusion is that interest rates react in the long run more than in proportion to inflation shocks, and the MPC takes particular notice of the more persistent components of inflation (non-food inflation in particular) and of survey data on inflation expectations in its decisions. Results from discrete choice models indicate that the results are robust, at least in terms of the direction of monetary policy adjustments. Therefore, the indication is that since the formal adoption of inflation targeting, the Bank of Ghana has conducted monetary policy in the theoretically recommended manner.

6.1 Monetary policy in other countries

How does the estimate of 2.13 for the long-run inflation coefficient in Ghana's monetary policy reaction function under inflation targeting (see Table 7) compare with figures for other countries? Martin and Milas (2009, Table 1) estimate a figure of 1.58 for the United States over the period 1983 to 2003. Although the United States has not formally adopted inflation targets, it is widely regarded as pursuing a monetary policy equivalent to inflation targeting. Cukierman and Muscatelli (2008, Table 1) estimate a smooth transition model for the United Kingdom, and for the period 1992 (the year it adopted inflation targeting) to 2005 they estimate an inflation coefficient of 2.25 for inflation below target, up to 6.76 for inflation well above target. De Brouwer and Gilbert (2005, Table 3) find an inflation coefficient of about 2.3 for expected inflation in Australia, another country which adopted inflation targeting, over the period 1991 to 2001. Sauer and Sturm (2007, Tables 2 and 3) and Gorter et al. (2008, Table 1) both find that the European Central Bank (ECB)'s inflation coefficient is close to zero using actual inflation, but well above

one using expected inflation: Sauer and Sturm's estimate is about 1.9 using survey data for 1991 to 2003, and Gorter et al.'s estimate in their benchmark model is 1.39 for the period 1997-2006. Therefore, in terms of the long-run reaction of interest rates to an inflation shock, Ghana's monetary policy under formal inflation targeting has been fairly similar to other central banks which have managed to control inflation successfully.

However, even if the long-run reaction to inflation shocks is sufficiently large, it is possible that the short-run reaction is not (i.e. the reaction is too slow). In Model 1 of Table 7, the coefficient of the lagged policy rate of – 0.11 for Ghana implies a half-life of 11.55 to 13.86 months, given that meetings occur about every two months.[22] In other words, it takes almost a year or a bit more than a year for interest rates to get half-way towards their long-run reaction to a shock. This may seem to be unnecessarily long, but is it significantly longer than in countries that are regarded as successful inflation targeters? We can look at the estimates for a persistence (or smoothing) parameter in the partial adjustment equation of interest rate for some central banks, which in our case is the parameter ρ (see equation (2)), estimated to be 0.89 (=1-0.11) in Table 7. Cukierman and Muscatelli (2008, Table 1), using quarterly data for the United Kingdom from 1992 to 2005, estimate a persistence parameter of 0.84, and De Brouwer and Gilbert (2005, Table 3), using quarterly data for Australia from 1991 to 2001, obtain a persistence parameter value ranging between 0.86 and 0.97. Both papers, in relation to these estimates, comment on the gradual

[22] By a half-life, we mean how long it takes for an interest rate to change by a half of the long-run reaction. With the short-run inflation coefficient of 0.23 and the lagged policy rate coefficient of -0.11 (Table 7, Model 1), we can get the half-life as follows. Suppose that inflation (expectation) rises by one percentage point in period t. Then, the accumulated rise in interest rates in period t+x (i.e., x periods later) is obtained as 0.23+0.23*0.89+0.23*(0.89)^2+ … +0.23*(0.89)^x percentage points, where 0.89(=1-0.11) is the persistence parameter of ρ (see equation (2)). Then, given that the long-run coefficient is 2.13, the half-life is the value of x which corresponds to an accumulated increase of 1.07, which is between x=5 and 6. Then, given that there were 52 meetings in the sample period of 10 years, and the average length of one period is thus 2.31 (in line with the fact that meetings are typically bi-monthly), the half-life is obtained as between 11.55 and 13.86 months.

nature of interest rate adjustment to the desired level in respective countries. Notice that a persistence parameter of 0.90 in quarterly data, together with the long-run coefficient of 2.3 (as in De Brouwer and Gilbert, 2005, Table 3), implies a half-life of about 5 to 6 quarters, a bit longer than our estimate for Ghana. However, Sauer and Sturm (2007, Table 3) report a persistence parameter of 0.87 in monthly data for the ECB, which, together with the long run coefficient of 1.9, implies a half-life of only four months. Therefore, while the speed of interest rate reaction in Ghana appears to be certainly slower than the ECB, it may not necessarily be slower than other successful central banks such as the Reserve Bank of Australia.[23]

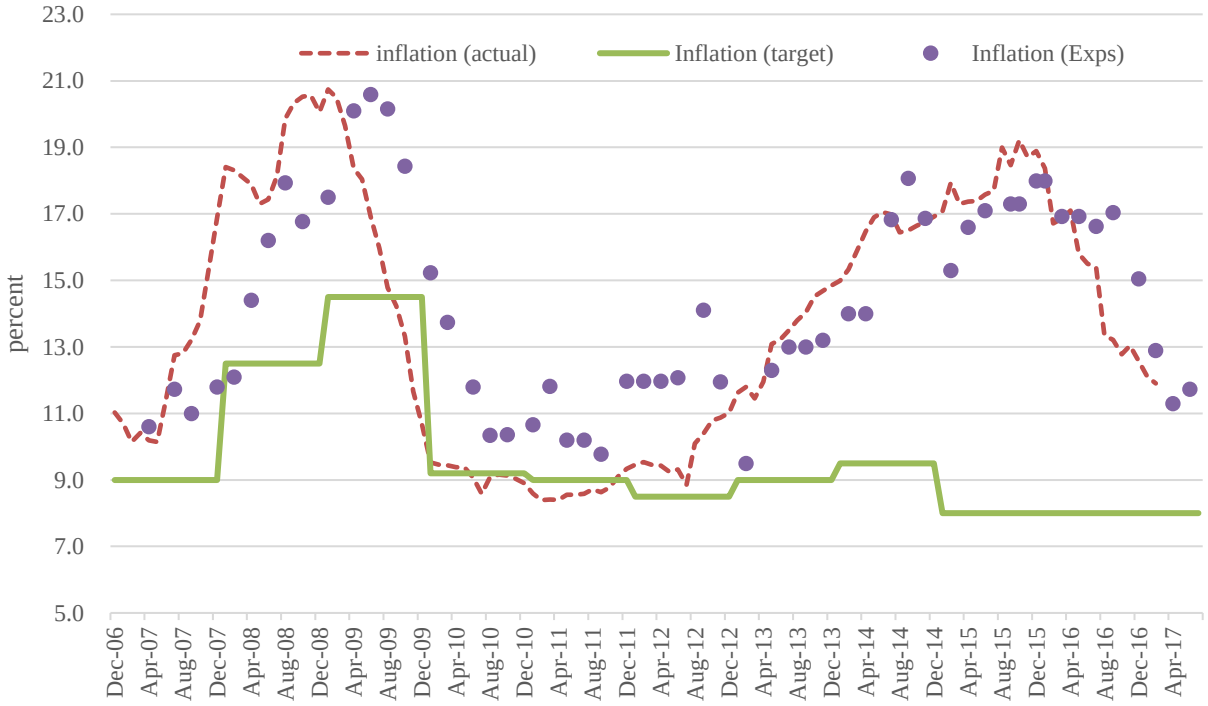
6.2 Why has inflation been high under inflation targeting?

The natural question then is: if monetary policy reaction functions are similar to those estimated for countries with successful monetary policies, and interest rates respond to inflation shocks in the theoretically recommended manner, what explains the actual failure to reduce the average inflation rate? Although a formal investigation of this question is beyond the scope of this study, we present one conjecture here. To do this, notice first that what stands out in the case of Ghana is the Bank's apparent failure to anchor inflation expectations, which are substantially higher than official target inflation: Table 2 (above) shows that while the sample mean of target inflation is 9.6%, the mean of expected (and actual) inflation is 14.5% (13.6%). Figure 3 further highlights this deviation of expected inflation from the target, showing that inflation expectation has been

[23] Another way of considering the relative size of short-run reaction is to examine the estimated interest rate reaction after an intermediate length of time (six months, say). In the case of Ghana, assuming meetings every two months, this figure is $0.23(1+0.89+0.89^2+0.89^3)=0.78$. In fact, this is a bit larger than De Brouwer and Gilbert's (2005, Table 3) estimate for Australia of 0.62 (again using a quarterly persistence parameter of 0.90 and a long-run coefficient of 2.3), although much less than the 1.18 for the ECB implied by Sauer and Sturm's estimates.

persistently above the target. The indication is thus that private agents clearly do not find the target plausible, which, in turn, naturally makes it difficult for the Bank to reduce actual inflation.

Figure 3: Inflation (expectations, actual and targets)



However, why may private agents find that the target is not plausible? One conjecture is that agents may perceive that the Bank's prime objective of price stability is somewhat compromised irrespective of the Bank's sound reactions to various economic shocks. Specifically, in the light of the emphasis in the literature on the absence of fiscal dominance (i.e., the subordination of monetary policy to fiscal requirements) as a key pre-requisite for successful IT performance (cf. Masson et al., 1997), any hint of fiscal dominance may prompt agents to think that the Bank's pledge to control inflation is not credible. In Ghana the fiscal deficit increased massively from below 5% of GDP in 2011 to over 11% of GDP in 2012, and this coincided with

the beginning of a significant upward trend in both actual and expected inflation that lasted until 2015.

In Table 9 we present a regression where inflation expectations are regressed on lagged inflation, lagged output gap, lagged exchange rate depreciation, and the fiscal balance of current and previous years.[24] As Figure 3 suggests, inflation expectations are highly correlated with the lagged inflation rate, and this is the only variable that is significant at the 1% level. The lagged output gap and exchange rate depreciation have the expected positive signs, with the former (latter) being significant at the 5% (10%) level. In Model 1 the current-year and previous-year fiscal balance are included separately. The current-year balance has the expected negative coefficient, indicating that a higher deficit is associated with increased inflation expectations, and the previous-year balance has a positive coefficient of somewhat larger magnitude. This suggests that inflation expectations respond to the change in the fiscal balance, and this is the specification used in Model 2. The change in the fiscal balance has the expected negative sign, but it is not statistically significant.

There is thus some weak support for the hypothesis that Ghana still has a fiscal dominance problem, in spite of the adoption of inflation targeting, and that this has some influence on inflation expectations. To elaborate, to the extent that inflationary pressure of a fiscal origin induces the creation of formal and informal indexation mechanisms in the private sector, an inflation-targeting central bank will find it difficult to align inflation expectations, an intermediate target under the regime, to the announced target rate. Whatever the reason is for the persistence of above-target

[24] We use lagged values of inflation, output gap, and exchange rate depreciation, because inflation expectation is a predetermined variable (as explained above). Since fiscal deficits data are available only at an annual frequency, we use current and previous yearly values.

inflation in Ghana, however, an even tougher response to inflation shocks than in other countries may be required to keep inflation close to the target.

Table 9: Determinants of inflation expectations

	Model 1	Model 2
Constant	5.026***	4.852***
	(7.58)	(9.81)
Lagged inflation	0.750***	0.754***
	(12.13)	(11.84)
Lagged output gap	8.595**	8.106**
	(2.07)	(2.05)
Lagged depreciation against USD	5.515*	5.208*
	(1.83)	(1.71)
Lagged policy rate (%)	-0.042	-0.050
	(-0.89)	(-1.02)
Lagged policy rate change	0.393	0.383
	(1.49)	(1.50)
Fiscal balance/GDP (%, current year)	-0.031	
	(-0.41)	
Fiscal balance/GDP (%, 12 months lag)	0.068	
	(0.94)	
Change in Fiscal Balance/GDP		-0.050
		(-0.84)
Sample size	52	52
Adj R-squared	0.88	0.88

Notes: The dependent variable is the expected percentage inflation rate derived from the business survey as described in the text. For other variables see notes to Table 3. Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively.

6.3 Has monetary policy improved under inflation targeting?

We argued that the Bank of Ghana's monetary policy conduct itself has not been responsible for the persistently high inflation under formal inflation targeting, and suggested the possibility that the institutional problem of fiscal dominance may have been a reason for the poor performance. However, how did the adoption of inflation targeting, which clarifies price stability as an overriding objective, affect the manner in which the central bank reacts to inflationary shocks?

To examine this, we estimate our interest rate reaction function from November 2002, when the central bank was granted independence, rather than only from May 2007, when inflation targeting was formally adopted. The results are shown in Table 10. Model 1 assumes that the coefficients are constant throughout the period. The specification is the same as in Table 3, using actual inflation, but whereas in Table 3 the inflation coefficient was positive and significant at the 5% level, in Table 10 its coefficient is extremely small, with a *t*-statistic of close to zero. That suggests a marked shift in the coefficient once inflation targeting began. Accordingly, in Model 2 of Table 10 the inflation coefficient is allowed to differ after May 2007 from before. The inflation coefficient now shows the estimate for the period up to April 2007, before the adoption of IT, and the inflation coefficient interacted with the IT dummy indicates the shift in this coefficient once IT was adopted. The inflation coefficient for the pre-IT period in Model 2 is actually negative, at -0.05, and the coefficient of the interaction variable is significantly positive at the 5% level, with a coefficient of 0.14. Thus there seems to have been a clear shift in monetary policy after the adoption of IT, with the control of inflation being given a significant weight in a way that it had not been previously, conforming to the primary objective of inflation targeting. In turn, this may imply that without inflation targeting, inflation would have been even higher since 2007.

Table 10: Including the pre-inflation-targeting period (2002:11 - 2017:05)

Model	*OLS*	*OLS*
	Model 1	Model 2
Dependent variable: change in policy interest rate		
Inflation less target (% p.a.) †	0.005	-0.051
	(0.10)	(-1.21)
Output gap‡	3.463	4.181
	(1.32)	(1.63)
Lagged depreciation against USD§	1.391	0.390
	(0.48)	(0.14)
Lagged policy rate (%)	-0.030	-0.055
	(-0.75)	(-1.44)
Lagged policy rate change	0.396***	0.316**
	(3.29)	(2.46)
Inflation-targeting dummy§		-0.386
		(-1.08)
IT dummy * (inflation less target)		0.137**
		(2.09)
Constant	0.434	1.009
	(0.77)	(1.43)
Long-run inflation effect 2002-2017	*0.17*	
Long-run inflation effect 2007-2017		*1.56*
Adj R-squared	0.21	0.27
Observations	75	75

Notes: †Deviation of actual inflation from target rate. ‡Measured as deviation of log composite index of economic activity from potential derived from HP filter. §Monthly change in local currency units/$ (+depreciation/-appreciation). §Inflation-targeting dummy =1 from May 2007 onwards, = 0 otherwise. Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively. The long-run coefficient is the short-run coefficient divided by minus one times the lagged policy rate coefficient.

7 Conclusion

Ghana stands out as an inflation-targeting country where inflation has been persistently some way above the target. The question posed here was whether that could be attributed to the conduct of monetary policy. To our knowledge this is the first study to estimate monetary policy reaction functions for Ghana under the formal IT regime of the post-2007 period.

What we have found is that the reaction function in Ghana is similar to that estimated for countries where monetary policy is regarded as successful. The estimated long-run reaction of interest rates to inflation shocks is well above the theoretically recommended threshold of one. Moreover, the details of the inflation response are also consistent with theory. More notice is taken of non-food price inflation, which is more persistent than food price inflation, and therefore a better indicator of future inflation. More notice is also taken of expected inflation as revealed by the Bank's regular survey of business than of historical inflation, which is consistent with the notion that interest rate changes affect inflation with a sizable lag. Besides, the comparison of interest rate reaction functions with the pre-formal IT period of 2002-2007 reveals that the Bank under the formal IT period has actually given a significantly more weight on inflation control. Although the interest rate adjustment seems to be only gradual in Ghana, and certainly more gradual than some central banks, it does not appear to be outside the range for successful central banks in general.

Therefore, our findings naturally raise the question of why inflation has not been closer to the Bank's target despite the apparently sound monetary policy reactions. A formal investigation of this issue is beyond the scope of this paper, but one conjecture is that Ghana may still suffer from weak institutions, which in turn create a fiscal dominance problem, making it difficult for the Central Bank to align inflation expectations to the announced target rate. Another, perhaps more

speculative, reason for the persistently high inflation under the formal IT regime may be a weak monetary transmission mechanism. In particular, to the extent that a bank lending channel, which emphasises the special nature of bank credit in the financial structure, is impaired, a monetary tightening may not reduce bank lending, making it difficult to control inflation. Formal investigation of this possibility is also left for a future work.

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Appendix A: Time series properties of variables

Here, we present the results of two different unit root tests (ADF test and Phillips-Perron test) applied to the key variables for the period from May 2007 (when inflation targeting was formally adopted) to May-2017.

Table A1. Unit Root Tests

	ADF TEST		PHILLIPS-PERRON TEST	
Variable	Level	First Difference	Level	First Difference
Policy interest rate	-1.2018	-4.6451***	-1.0873	-4.6698***
Inflation less target (% p.a.)	-1.1927	-5.8797***	-1.4487	-5.8916***
Inflation (core) less target	-1.9076	-4.7989***	-1.4339	-4.6858***
Inflation food less inflation target	-1.9350	-6.8586***	-2.0020	-6.8586***
Inflation non-food less inflation target	-1.3718	-6.3996***	-1.5476	-6.4120***
Inflation expectations less target	-1.9463	-7.5615***	-1.9463	-7.6607***
Output gap	-2.0368	-13.5408***	-4.2105***	-14.305***
Exchange rate (GHS/USD)	-0.3460	-6.2075***	-0.4293	-6.2999***

*, ** and *** Significant at the 10, 5 and 1 percent levels respectively.

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