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Abstract

An inflation-targeting regime has been in place in Ghana since 2007, but compared to other inflation-targeting countries it has been conspicuously unsuccessful. Since 2013 inflation has persistently exceeded the announced target by four percentage points or more, 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 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, one country where inflation targeting seems to have been singularly unsuccessful is Ghana, the first low-income country in Africa to adopt IT.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.

In this paper we investigate whether the conduct of monetary policy explains why inflation targeting in Ghana has not been more successful. Theory indicates that, for monetary policy to control inflation successfully, positive inflation shocks must be met by policy measures to 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

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 low-income countries in Africa, Ghana was followed by Uganda in 2011.

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 to that in countries that are regarded as having been successful in controlling inflation. 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 in the formal inflation-targeting period.³

2 Background

Figure 1 shows a graph of the policy interest rate (monetary policy rate, MPR), 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 was very close to the target. From 2013 to 2015, however, inflation steadily increased, and interest rates were raised as high as 26% by November 2015. On average inflation has exceeded the target by a substantial margin, despite the fact that the target has been relatively unambitious by international standards. 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 (Brazil, if inflation rate in 2016 is used; Turkey, if five-year average till 2016 is used).

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.

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

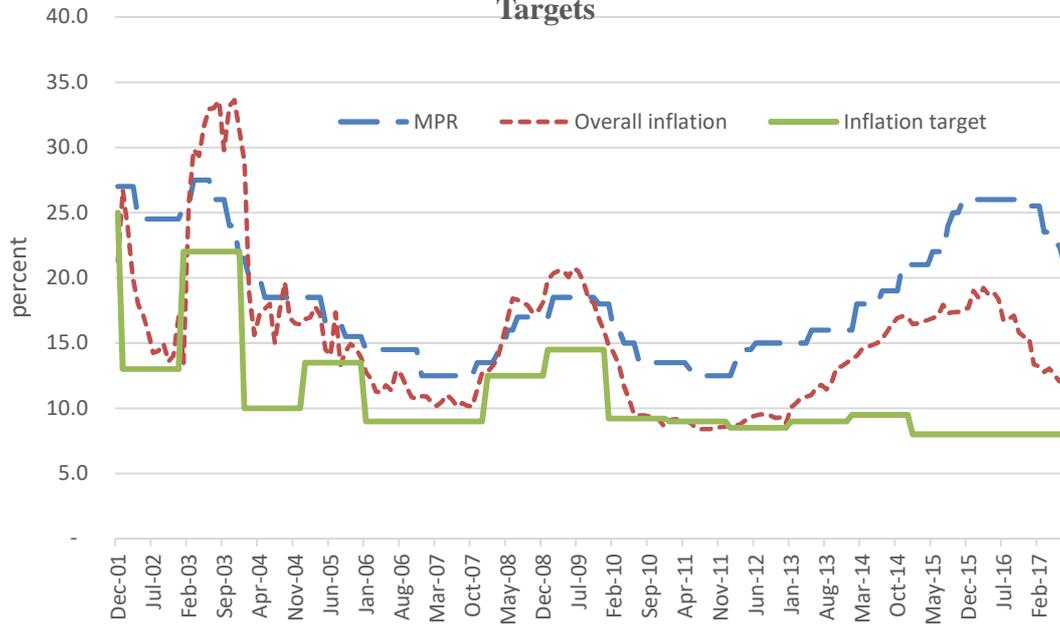
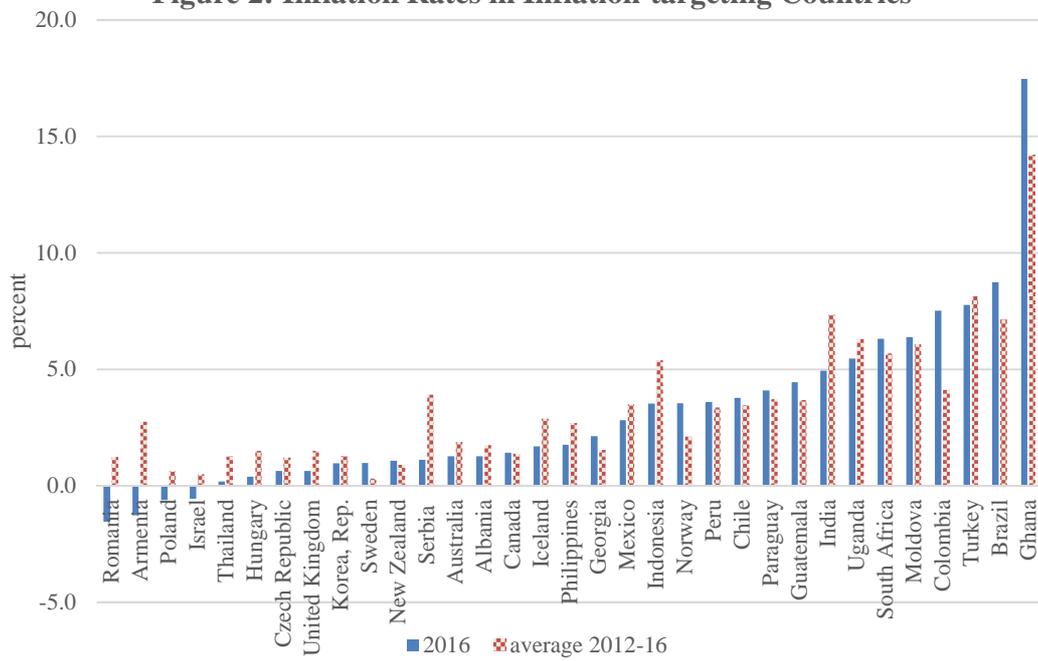


Figure 2: Inflation Rates in Inflation-targeting Countries



The Monetary Policy Committee of the Bank of Ghana, which consists of 7 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

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.

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	<i>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*.</i>
May 13, 2015	+1%	22.0	<i>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</i>
July 15, 2015	+2%	24.0	<i>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</i>
Sept. 14, 2015	+1%	25.0	<i>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.</i>
Nov. 16, 2015	+1%	26.0	<i>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</i>
Jan. 25, 2016	No change	26.0	<i>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</i>
Mar. 21, 2016	No change	26.0	<i>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</i>

			<i>commodities and financial markets and tight external financing conditions; 8. Relative stability in the forex market; 9. Risks to inflation and growth outlook balanced.</i>
May 16, 2016	No change	26.0	<i>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</i>
Jul. 18, 2016	No change	26.0	<i>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</i>
Sept. 19, 2016	No change	26.0	<i>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,</i>
Nov. 21, 2016	-0.5%	25.5	<i>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.</i>
Jan. 23, 2017	No change	25.5	<i>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.</i>
Mar. 27, 2017	-2%	23.5	<i>1. Underlying inflation pressures have eased considerably; 2. Growth is likely to remain significantly below potential</i>
May 22, 2017	-1%	22.5	<i>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</i>
Jul. 18, 2017	-1.5%	21.0	<i>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.</i>

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

3 Empirical methodology

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:

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

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:

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

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:

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.

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

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 (of the order of 0.1 for most countries), the short-run coefficient will be many times smaller than the implied long-run effect (see Clarida *et al.*, 1998, for example).

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:

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

where E denotes the expectation operator. 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 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). 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:

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

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:

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

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).⁸ 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 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 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 the formal adoption of inflation targeting in May 2007 up to the 76th MPC meeting in May 2017.

⁸ A number of studies, including the recent study of Muñoz Torres and Shepherd (2014), use limited dependent variable techniques to model interest rate setting.

Since the MPC's meetings are typically bi-monthly, we average the monthly data since the previous meeting to generate the current values of variables. For instance, for a meeting in January, we average data available for December and January. 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, 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).

As an alternative to actual inflation, we also use inflation expectations from the business confidence survey reported by the Bank. 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%. This is one of several questions from a survey the Bank conducts before each round of MPC meeting across key business establishment across the country. 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 expectation 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% the 10-15% range, 8.8% the 16-20% range, 2% the 21-25% range and 1% the 26-30% range, the derived inflation expectation for that period will be 11.65%. The index so computed is then compared to the inflation target to

derive the expected inflation gap.⁹ 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.¹⁰ 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.¹¹

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.

Table 2 provides summary statistics of the variables. 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% over the period of this study. Inflation averaged 13.6%, 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%, even further above the target than actual inflation, which seems to suggest that the Bank has not yet managed to anchor inflation expectation properly. During the sample period, the MPC made 52 policy rate decisions, more than half of which (31 meetings, 59.6%) were to leave interest rates unchanged. On 23.1% of the occasions (12 meetings), the

⁹ 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.

¹⁰ 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.

¹¹ 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.

decision was to raise the policy rate, and on 17.3% of the occasions (9 meetings), the policy rate was cut. Movements in either direction were between 0.5 and 2.0 percentage points.

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

<i>Variable</i>	<i>Mean or sample (%)</i>	<i>sd</i>	<i>min</i>	<i>max</i>
Policy rate	17.8	4.6	12.5	26.0
Changes	0.1	0.8	-2.0	2.0
<i>Distribution of MPR changes</i>				
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) [‡]	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. [‡] Inflation expectations of key business establishments across the country reported by BoG. [‡] This is deviation of expected inflation from the target. ^{!!} CIEA stands for Composite Index of Economic Activity.

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 (for example, 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.¹²

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.

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, but they are not all statistically significant. The difference between 12-month actual inflation and the target has a positive

¹² 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).

coefficient that is significant at the 5% level, but in magnitude it is only 0.147, which implies that in the short run nominal interest rates rise by only 15% 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 0.147 by minus one times the coefficient of the lagged policy rate, which is -0.10, and this yields a long-run coefficient of 1.47. Since this comfortably exceeds one, the implication is that monetary policy in Ghana is consistent with theoretical prescriptions for successful inflation targeting. The output gap and exchange rate depreciation also have positive coefficients, with the former being significant at the 10% level.

In the second and third columns of Table 3, 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 all more statistically significant than for Model 1 (indeed almost all are significant at the 5% level), 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)

<i>Model</i>	<i>OLS</i>	<i>Ordered logit</i>	<i>Ordered probit</i>
	Model 1	Model 2	Model 3
Dependent variable: change in policy interest rate	<i>Continuous</i>	<i>1: decrease, 2: no change, 3: increase</i>	
Inflation less target (% p.a.) [†]	0.147** (2.18)	0.443** (2.35)	0.263** (2.43)
Output gap [‡]	5.62* (1.77)	21.23** (2.10)	11.81** (2.21)
Depreciation against USD [§]	2.46 (1.04)	11.99* (1.94)	6.97** (2.02)
Lagged policy rate (%)	-0.10* (-1.71)	-0.30** (-2.19)	-0.18** (-2.15)
Lagged policy rate change	0.10 (0.80)	1.41** (2.13)	0.83** (2.27)
Constant	1.05 (1.34)		
cut1			
Constant		-2.75 (-1.15)	-1.64 (-1.15)
cut2			
Constant		2.13 (0.87)	1.19 (0.81)
Adj R-squared	0.37		
Pseudo R-squared		0.34	0.35
Pseudolikelihood	-46.27	-32.43	-32.07
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.

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 (0.127 compared with 0.147) and the output gap coefficient larger (7.65 compared with 5.62). However, the coefficient of the lagged policy rate is also slightly smaller (-0.09 instead of -0.10), which means that the estimated long-run inflation coefficient of $0.127/0.09=1.41$ is similar to that in Table 3. 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)

<i>Model</i>	<i>OLS</i>	<i>Ordered logit</i>	<i>Ordered probit</i>
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	<i>Continuous</i>	<i>1: decrease, 2: no change, 3: increase</i>	
Inflation (core) less target [†]	0.127** (2.22)	0.619*** (2.59)	0.335** (2.46)
Output gap [‡]	7.65** (2.45)	29.36*** (3.03)	16.80*** (3.25)
Depreciation against USD [§]	3.58 (1.42)	18.14** (2.41)	9.85** (2.55)
Lagged policy rate (%)	-0.09* (-1.70)	-0.45** (-2.42)	-0.24** (-2.31)
Lagged policy rate change	0.19* (1.92)	1.78*** (2.88)	1.00*** (3.01)
Constant	1.06 (1.43)		
cut1			
Constant		-4.69* (-1.70)	-2.41 (-1.55)
cut2			
Constant		0.52 (0.22)	0.47 (0.33)
Adj R-squared	0.34		
Pseudo R-squared		0.38	0.38
Pseudolikelihood	-47.27	-30.64	-30.72
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

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, 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*** (6.45)	0.013*** (7.32)
Lagged inflation	0.007 (0.08)	0.153* (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 *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 non-food price coefficient is four times as great as the food price coefficient, 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.

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. 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.¹³ 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 0.193 is some 30% greater than the 0.147 estimated for actual inflation in Table 3. With a lagged policy rate coefficient of 0.09, the estimated long-run coefficient is $0.193/0.09=2.14$, 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 about twice as large in Table 7 as in Table 3. The output gap has similar coefficients to Table 3, but depreciation against the US dollar is less significant, which suggests that it is a factor that is already taken into account in business expectations.

¹³ Section 4 provides a comprehensive review of how this is computed.

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

<i>Model</i>	<i>OLS</i>	<i>Ordered logit</i>	<i>Ordered probit</i>
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	<i>Continuous</i>	<i>1: decrease, 2: no change, 3: increase</i>	
Inflation_food less inflation target [†]	0.022 (0.57)	0.082 (0.55)	0.058 (0.71)
Inflation_non-food less inflation target [†]	0.091* (1.96)	0.248* (1.90)	0.143** (2.01)
Output gap [‡]	6.19* (1.97)	22.40** (2.25)	12.43** (2.39)
Depreciation against USD [§]	2.39 (1.01)	11.93* (1.90)	6.87** (2.00)
Lagged policy rate (%)	-0.08 (-1.58)	-0.24* (-1.95)	-0.14* (-1.91)
Lagged policy rate change	0.11 (0.80)	1.44** (2.18)	0.85** (2.32)
Constant	0.74 (1.07)		
cut1			
Constant		-1.61 (-0.76)	-0.97 (-0.76)
cut2			
Constant		3.22 (1.44)	1.82 (1.35)
Adj R-squared	0.36		
Pseudo R-squared		0.34	0.34
Pseudolikelihood	-46.23	-32.70	-32.38
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

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

<i>Model</i>	<i>OLS</i>	<i>Ordered logit</i>	<i>Ordered probit</i>
	Model 1	Model 2	Model 3
Dependent variable: Δ in policy rate	<i>Continuous</i>	<i>1: decrease, 2: no change, 3: increase</i>	
Inflation expectations less target [†]	0.193** (2.56)	0.910*** (2.62)	0.516*** (2.96)
Output gap [‡]	5.49* (1.91)	19.77** (2.03)	11.41** (2.20)
Depreciation against USD [§]	1.68 (0.59)	7.97 (0.95)	4.75 (1.11)
Lagged policy rate (%)	-0.09** (-2.11)	-0.46** (-2.57)	-0.26*** (-2.81)
Lagged policy rate change	0.04 (0.33)	1.03 (1.40)	0.63 (1.59)
Constant	0.63 (1.26)		
cut1			
Constant		-4.09 (-1.53)	-2.26 (-1.58)
cut2			
Constant		1.27 (0.50)	0.87 (0.62)
Adj R-squared	0.40		
Pseudo R-squared		0.40	0.41
Pseudolikelihood	-45.17	-29.61	-29.17
Observations	52	52	52

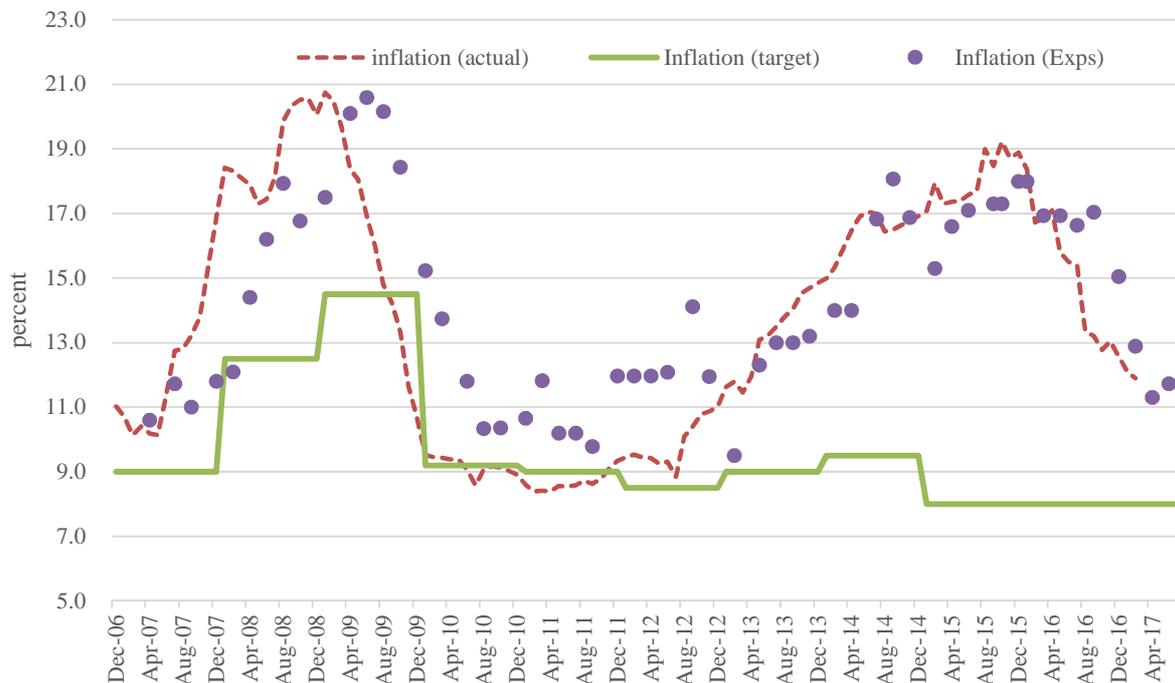
Notes: [†]Deviation of expected inflation from target rate. [‡]Measured as deviation of log composite index of economic activity from potential derived from HP filter. [§]Monthly change in local currency units/\$ (+depreciation/- appreciation). Robust t-statistics in parentheses. *, ** and *** Significant at the 10, 5 and 1 percent levels respectively

5.4 Summary of results and discussion

Having estimated variants of monetary policy reaction functions for Ghana under formal inflation targeting (2007-2017), our conclusion is that the Bank of Ghana's monetary policy decisions have not been significantly different from those of countries that are successful inflation targeters. Specifically, 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.

Then, the natural question is: if the Bank's policy reactions are consistent with successful IT performance, 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. Notice 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 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 8 we present regression results where inflation expectations are regressed on current inflation, the output gap, exchange rate depreciation and the fiscal balance. As Figure 3 suggests, inflation expectations are highly correlated with the current inflation rate, and this is the only variable that is significant at the 5% level. The output gap and exchange rate depreciation have the expected positive signs, and depreciation is significant at the 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 similar 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, although 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. We leave a formal investigation of this hypothesis to future work.

Table 8: Determinants of inflation expectations

Dependent variable: expected percentage inflation rate	Model 1	Model 2
Constant	4.090*** (6.13)	4.074*** (7.80)
Current inflation	0.745*** (19.65)	0.745*** (20.12)
Output gap	4.792 (1.31)	4.804 (1.32)
Depreciation against USD	5.504* (1.78)	5.481* (1.77)
Fiscal balance/GDP (% , current year)	-0.076 (-1.00)	
Fiscal balance/GDP (% , 12 months lag)	0.079 (1.39)	
Change in Fiscal balance/GDP		-0.077 (-1.35)
Observations	52	52
Adj R-squared	0.89	0.90

Notes: The expected percentage inflation rate is 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. 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 remarkably similar to that estimated for countries where monetary policy is regarded as successful. Since 2010 real interest

rates have been consistently positive, and 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. The speed of adjustment is similar to that in the advanced countries.

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 thorough investigation of this issue is beyond the scope of this paper, but there is some indication that Ghana still has a fiscal dominance problem that may be affecting inflation expectations.

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