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Inflation, Inflation Uncertainty, and Growth: Evidence from Ghana

Bernard Njindan Iyke[1], Sin-Yu Ho[2]

ABSTRACT Inflation and inflation uncertainty are critical factors influencing the functioning of markets and thus the efficient flow of economic activities. In this study, we investigated the effects of inflation and inflation uncertainty on growth in Ghana. Unlike the majority of the previous studies, we distinguished the short-run effects of inflation and inflation uncertainty on growth from the long-run effects. Also, unlike the previous studies, we examined whether increases in inflation uncertainty have the same effects on growth as decreases in it. By applying linear and nonlinear specifications to a data set covering the period 1963 to 2015, we found that inflation has both short and long-run negative effects on growth. Inflation uncertainty has a differential short-run effect and a negative long-run effect on growth. Increases in inflation uncertainty hurt growth, while decreases may reverse this pattern, albeit slowly. Both inflation and inflation uncertainty are critical determinants of growth in the country. To promote growth, policymakers should continue to pursue a low inflation target while ensuring minimal inflation uncertainty.

KEY WORDS: Inflation; Inflation Uncertainty; Growth; Ghana

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[1] Department of Finance, Deakin University, Australia; [2] Department of Economics, University of South Africa, South Africa

1. Introduction

The level of inflation and its movements over time have been the focus of nearly all central banks around the globe. The key reason is that inflation is a critical determinant of economic growth and societal welfare. In theory, high and volatile inflation hurts growth and welfare, while low and stable inflation enhances them (Dotsey & Sarte, 2000; Friedman, 1977; Gomme, 1993; Temple, 2000; Tommasi, 1994) – but this is not always the case. For example, Tobin (1965) contends that an increase in inflation uncertainty may increase per capita capital because households will move assets from non-interest-bearing accounts to real capital accounts, thereby enhancing capital productivity. In essence, high inflation uncertainty may promote capital productivity. In contrast, De Gregorio (1993) argues that inflation could force up the cost of capital, thereby inhibiting capital accumulation and capital productivity, which would in turn slow down long-run growth.

Apart from the separate effects of inflation and inflation uncertainty on growth, other theoretical studies have recognized the joint impact of these variables on growth. Friedman (1977) argues that increases in inflation are associated with inflation uncertainty, which weakens the price mechanism, thereby dampening economic activity and growth. In a formal model, Ball (1992) demonstrates that high inflation generates high

Correspondence concerning this article should be addressed to: **Bernard Njindan Iyke**, Department of Finance, Deakin Business School, Deakin University, 221 Burwood Highway, Melbourne Burwood Campus, Victoria 3125, Australia. E-mail: benitoflex@gmail.com

inflation uncertainty, which translates into even higher levels of future inflation, since the public will begin to doubt the credibility of the monetary authority. This mechanism hurts long-run growth. In contrast, Ungar and Zilberfarb (1993) argue that an increase in the level of inflation creates incentives for the public to devote resources to predicting its future path. In doing so, nominal inflation uncertainty will be lessened. Dotsey and Sarte (2000) argue that increases in inflation generate increases in inflation uncertainty, which enhances precautionary savings, investment and growth by discouraging the demand for real money balances and consumption. Similarly, Aghion and Saint-Paul (1998), and Blackburn (1999) contend that increases in inflation and inflation uncertainty promote growth in models with technological change, and research and development (R&D).

The empirical literature is not much different from the theoretical literature. The existing studies suggest that inflation and inflation uncertainty could hurt or enhance growth. First, there are studies that mainly focus on the impact of inflation on growth, without controlling for the role of inflation uncertainty. These studies include De Gregorio (1993), Gylfason and Herbertsson (2001), Gillman, Harris, & Mátyás (2004), and Guerrero (2006), among others. These studies have usually documented a negative impact of inflation on growth. Along this line of study in the literature, others have found evidence in support of a threshold relationship between inflation and growth. For example, in their studies, Sarel (1996), Bruno and Easterly (1998), Khan and Senhadji (2001), López-Villavicencio and Mignon (2011), Kremer, Bick and Nautz (2013), and Yilmazkuday (2013), found inflation to have a negative impact on growth beyond a certain threshold level of inflation. However, below this threshold, inflation affects growth positively or insignificantly, depending upon the country's level of development. Second, there are studies that are mainly concerned with the effect of inflation uncertainty on growth without controlling for inflation. Here, the findings are inconclusive. While some found inflation uncertainty to be associated with positive growth (Baharumshah, Hamzah, & Sabri, 2011; Bredin, Elder, & Fountas, 2009; Coulson & Robbins, 1985; Mohd, Baharumshah, & Fountas, 2013), others found negative effects (Apergis, 2005; Bredin & Fountas, 2005; Fountas, Karanasos, & Kim, 2002; Grier & Perry, 2000; Grier, Henry, Olekalns, & Shields, 2004; Grier & Grier, 2006; Heidari, Katircioglu, & Bashiri, 2013). In addition, Neanidis and Savva (2013) find that inflation uncertainty inhibits growth rates in a high-inflation regime. Finally, there are studies that have included both inflation and inflation uncertainty in their growth specifications and have found mixed results. For instance, Fischer (1993), and Judson and Orphanides (1999) found a negative impact of both inflation and inflation uncertainty on growth. Conversely, Grier and Grier (2006) found that inflation does not inversely affect growth once inflation uncertainty is accounted for. They argue that the negative impact of inflation on growth is indirectly linked to inflation uncertainty, in line with the Friedman-Ball hypothesis. Barro (2013) found inflation to negatively affect growth, while inflation uncertainty affected it positively.

From both the theoretical and the empirical literature, it is clear that the impact of inflation and inflation uncertainty on growth is not a conclusive matter. Both may affect growth negatively or positively depending upon whether they are treated separately or jointly in the model, or whether the model is based on a developed or a developing country. Additionally, while the separate effects of inflation and inflation uncertainty have been studied extensively, their joint effects have received less attention in the literature (Baharumshah, Slesman, & Wohar, 2016). Since the twin issues of lower inflation and price stability remain critical to the functioning of economic systems, further probing of the inflation and inflation uncertainty effects on growth is needed to inform macroeconomic decisions. It is worth noting that recent attempts to establish the effects of inflation and inflation uncertainty on growth have mainly utilised high-frequency data (Baharumshah et al., 2011; Fountas et al., 2002; Fountas & Karanasos, 2007; Grier & Grier, 2006; Heidari et al., 2013), which may not be readily available in the case of developing countries. Moreover, the economic conditions in developed economies are arguably relevant because they spill over to the rest of the world. It is therefore unsurprising that these studies have mainly focused on developed countries.

This study adds to the growing literature by jointly examining the effects of inflation and inflation uncertainty on growth in the case of a developing country, Ghana. We also explore whether increases in inflation

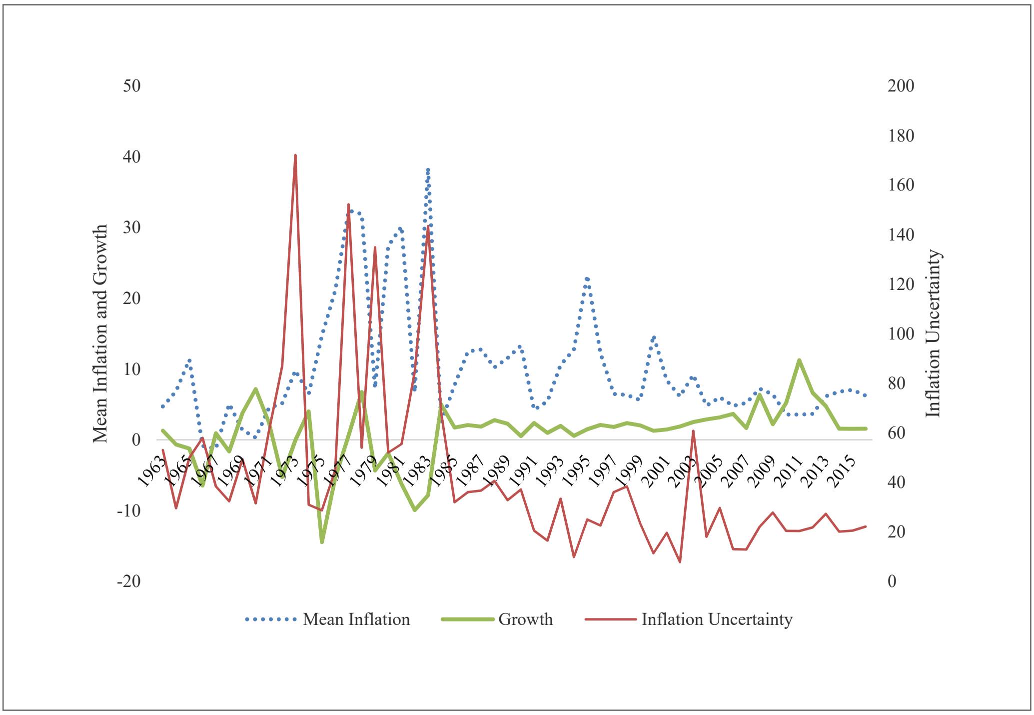

Figure 1. Inflation Uncertainty in Ghana, 1963–2015

Note: Inflation uncertainty is the annualized standard deviation as described in section 3; Mean Inflation is average inflation over 12 months. Growth is year-on-year percentage change in real GDP.

uncertainty have the same effects as decreases. To our knowledge, this is the first attempt at tackling the two issues simultaneously while focusing on a developing country. Ghana has endured frequent episodes of high inflation and inflation uncertainty (Iyke & Odhiambo, 2017). Inflation uncertainty was severe between 1963 and 1985 and moderate thereafter. The period of severe uncertainty is attributable to political instability, excessive state controls, the severe drought of the 1980s and adverse external developments (particularly the oil price shock of the 1970s), while the moderate period of uncertainty is attributable to the gradual shift to a market economy, political stability, and the adoption of the inflation targeting policy in 2007 (Heintz & Ndikumana, 2011; Iyke & Ho, 2017; Licklider, 1988; Owusu, 1989). Figure 1 shows this evidence. Therefore, studies such as this will be useful in explaining the effects of these inflationary conditions on the economy. The findings from this study may also have implications for neighboring countries such as Togo, Burkina Faso and Ivory Coast. Ghana trades with these countries. Hence, improvement in economic conditions in Ghana may have positive spillover effects on these countries.[1]

The rest of the paper is organized as follows. In the next section, we present the methodology. In section 3, we discuss the data and the empirical results. Section 4 concludes.

2. Methodology

To assess the effects of inflation and inflation uncertainty on growth, we defined growth as a function of the interest rate, inflation and inflation uncertainty. Our simple model is of the following form:

$$lnY_t = \alpha_0 + \alpha_1 R_t + \alpha_2 lnINF_t + \alpha_3 VOL_t + \mu_t, \tag{1}$$

where Y is economic growth; R is the nominal interest rate; INF denotes inflation; VOL is a measure of inflation uncertainty; ln is the natural logarithm operator; $\boldsymbol{\alpha} = (\alpha_0, \alpha_1, \alpha_2, \alpha_3)'$ are the coefficients of the model; μ is the white-noise error term; and t is the time subscript.

In line with the theory, an increase in the nominal interest rate should raise the cost of borrowing and decrease the level of investment and output in the economy (see Mundell, 1963). Therefore, the estimated value of α_1 should be negative. An increase in the level of inflation is expected to hurt growth (Ball, 1992; Friedman, 1977). Hence, α_2 is expected to be negative. Inflation uncertainty may hurt or enhance growth (Aghion & Saint-Paul, 1998; Ball, 1992; Blackburn, 1999; Friedman, 1977). Thus, α_3 is expected to be either negative or positive.

The limitation of Eq. (1) is that it only permits the study to estimate the long-run impact of inflation and inflation uncertainty on growth. However, the cumulative short-run impacts of these factors on production and consumption are critical in explaining the long-run growth prospects of a country. Therefore, it is important to examine to light the short-run impacts of inflation and inflation uncertainty as well. In a limited data environment, the autoregressive distributed lag (ARDL) framework developed by Pesaran, Shin and Smith (2001) is very suitable for estimating both short and long-run impacts of macroeconomic variables in a time series model. Apart from this important feature, the ARDL framework is also superior in that it does not require pretesting the integration properties of the variables. Hence, it avoids the pretesting bias problem to which other approaches are prone. Additionally, the approach is applicable regardless of whether the variables are I(0), I(1), a mixture of both, or are fractionally integrated. A dynamic specification of Eq. (1) in the ARDL setting will be of the following form:

$$\Delta lnY_t = \beta_0 + \sum_{i=1}^{q}\beta_{1i}\,\Delta lnY_{t-i} + \sum_{i=0}^{q}\beta_{2i}\,\Delta R_{t-i} + $$
$$+ \sum_{i=0}^{q}\beta_{3i}\,\Delta lnINF_{t-i} + \sum_{i=0}^{q}\beta_{4i}\,\Delta VOL_{t-i} + $$
$$+ \delta_1 lnY_{t-1} + \delta_2 R_{t-1} + \delta_3 lnINF_{t-1} + \delta_4 VOL_{t-1} + \epsilon_t, \tag{2}$$

where ϵ, β, and δ are the white-noise error term, the short-run and the long-run coefficients of the model, respectively; Δ is the first-difference operator; and q is the maximum lag of the model. The short-run effects are the coefficients of the first-differenced variables. The long-run effects are obtained by setting the non-first-differenced lagged component of Eq. (2) to zero and normalizing δ_2 to δ_4 on δ_1. Therefore, the long-run effects of inflation and inflation uncertainty on growth will be δ_3 / δ_1 and δ_4 / δ_1, respectively.

The results are reliable if the coefficients are structurally stable, serial correlation and heteroskedasticity are absent, the functional form of Eq. (2) is correctly specified, and there is evidence supporting cointegration. The former four conditions are tested using a battery of diagnostic tests outlined in the results section, while cointegration is tested through the joint significance of the coefficients δ_1, δ_2, δ_3, and δ_4. That is, we can verify the existence of cointegration by testing the hypothesis that $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$. Pesaran et al. (2001) have tabulated two sets of critical values under this null hypothesis. The first set of critical values are tabulated by assuming that the variables in Eq. (2) are integrated of order zero, I(0), while the second set are tabulated by assuming that they are integrated of order one, I(1). We can reject the presence of cointegration if the calculated F-statistic is smaller than the first set of critical values. Similarly, we fail to reject the presence of cointegration if the calculated F-statistic is larger than the second set of critical values. The test is inconclusive if the calculated F-statistic lies in-between both sets of critical values.

An issue that may still arise, thereby biasing our results, is reverse causality in the relationship between inflation uncertainty and growth. While a rise in the level of inflation uncertainty may lead to a fall in economic growth (Ball, 1992; Friedman, 1977), an improvement in economic conditions may also reduce the level of uncertainty. To address potential reverse causality, Glas and Hartmann (2016) employed an instrumental variable technique. We took this concern into consideration when using the ARDL technique. The ARDL model treats all variables as endogenous by permitting a flexible selection of the dynamic lag structure and short-run reverse causality (Ho & Iyke, 2017; Pesaran et al., 2001, p. 299).

In addition to assessing the impact of inflation and inflation uncertainty on growth, we also want to know whether increases in inflation uncertainty have the same impact on growth as decreases. To achieve this objective, we reformulate the ARDL specification in

Eq. (2) into a nonlinear form. We followed Shin et al. (2014) by decomposing the variable of interest – in this case, inflation uncertainty – into positive and negative partial sums as follows:

$$VOL = VOL_0 + VOL_t^+ + VOL_t^-, \tag{3}$$

where VOL_t^+ and VOL_t^- are the partial sums of the positive and negative changes in inflation uncertainty, VOL, respectively. These are defined as:

$$\begin{aligned} POS = VOL_t^+ &= \sum_{j=1}^{t} \Delta VOL_j^+ = \sum_{j=1}^{t} \max(\Delta VOL_j, 0) \\ NEG = VOL_t^- &= \sum_{j=1}^{t} \Delta VOL_j^- = \sum_{j=1}^{t} \min(\Delta VOL_j, 0) \end{aligned} \tag{4}$$

To arrive at the nonlinear ARDL specification of Eq. (2), we replaced inflation uncertainty, VOL, with POS and NEG. The obtained nonlinear ARDL specification is of the form:

$$\begin{aligned} \Delta lnY_t = {} & \beta_0 + \sum_{i=1}^{q} \beta_{1i}\, \Delta lnY_{t-i} + \sum_{i=0}^{q} \beta_{2i}\, \Delta R_{t-i} + \\ & + \sum_{i=0}^{q} \beta_{3i}\, \Delta lnINF_{t-i} + \sum_{i=0}^{q} \beta_{4i}\, \Delta POS_{t-i} + \\ & + \sum_{i=0}^{q} \beta_{5i}\, \Delta NEG_{t-i} + \delta_1 lnY_{t-1} + \delta_2 R_{t-1} + \\ & + \delta_3 lnINF_{t-1} + \delta_4 POS_{t-1} + \delta_5 NEG_{t-1} + \epsilon_t . \end{aligned} \tag{5}$$

Note that the coefficients and the white-noise error term in Eq. (5) are different from those in Eq. (2). Nonlinearity is introduced into the model through the partial sums POS and NEG. Changes in inflation uncertainty have linear effects on growth, if the coefficients of POS and NEG have the same sign and size. Otherwise, increases and decreases in inflation uncertainty have different or nonlinear effects on growth. The short-run effects are the coefficients of the first-differenced variables, while the long-run effects are calculated by setting the non-first-differenced lagged component of Eq. (5) to zero and normalizing δ_2 to δ_5 on δ_1. The long-run effects of POS and NEG on growth are, therefore, δ_4 / δ_1 and δ_5 / δ_1, respectively. Shin et al. (2014) have demonstrated that the bounds testing approach of Pesaran et al. (2001) is applicable in this case. In the following section, we present the empirical results obtained by applying these models to data.

3. Empirical Results

This section presents the empirical results obtained by applying the above specifications to the data. The data used in this study covers the period 1963 to 2015. A recent study has shown that the relationship between *ex ante* uncertainty and *ex post* performance is weak (Abel, Rich, Song, & Tracy, 2016). Hence, a preferable measure of inflation uncertainty would be one based on survey data because these data are the least noisy and are measured *ex ante*. However, survey data on inflation uncertainty is limited in Ghana. Therefore, to obtain the measure of inflation uncertainty, we extracted monthly consumer price index (CPI) data for the period March 1963 to December 2015 from the International Financial Statistics (IFS) data set. Using this data, we obtained the logarithm of the annualized monthly inflation [i.e., $ln(CPI_t / CPI_{t-1}) x1200$] and used it to calculate the annualized standard deviation (VOL) as our measure of inflation uncertainty. Since extended growth data for Ghana is available only annually, we calculated our measure of inflation as the mean annualised monthly difference of the logarithm of CPI and denoted it as $lnINF$. We measured economic growth (lnY) as the annual difference of the logarithm of GDP per capita calculated using GDP per capita (constant 2010 US$). Data on this variable comes from the World Development Indicators (WDI) data set. We included interest rate to denote monetary policy stance. This variable is measured in this study as the central bank policy rate (R) using data from the IFS. The descriptive statistics of these variables are shown in Table 1.

To assess the effects of both inflation and inflation uncertainty on growth, we estimated Eq. (2) by restricting the maximum lag in the model to two. A maximum lag of two is sufficient when dealing with annual data (Iyke & Odhiambo, 2015; 2016). We then employed the Akaike information criterion (AIC) to select the optimal lags for each of the variables. The short and long-run results obtained are shown in Table 2. The preferred model in this case is ARDL (2, 0, 0, 2). The assumption that the error term in our specification is iid may not hold in reality, thereby biasing our results. Hence, we performed a battery of diagnostic tests to ensure that these results are reliable. These diagnostic tests are, respectively: the Lagrange Multiplier (LM) test, Ramsey's Regression Equation Specification

Table 1. Descriptive Statistics of the Variables

Statistics	*ln*Y	R	*ln*INF	VOL
Mean	0.381	18.141	9.910	43.502
Median	0.786	16.000	6.811	32.392
Maximum	4.630	45.000	38.456	172.106
Minimum	-6.780	4.500	-1.252	7.814
Std. Dev.	1.956	10.998	8.649	35.721
Skewness	-1.321	0.800	1.680	2.130
Kurtosis	5.787	3.000	5.331	7.215
Jarque-Bera	32.602	5.653	36.941	79.336
P-value	0.000	0.059	0.000	0.000
Sum	20.231	961.500	525.241	2305.615
Sum Sq. Dev.	199.114	6290.689	3890.013	66351.480
Observations	53	53	53	53

Note: Std. Dev. and Sum Sq. Dev. denote, respectively, standard deviation and sum of squared deviations. *ln* denotes the natural log operator.

Error Test (RESET), the Breusch-Pagan-Godfrey test for heteroskedasticity, the Cumulative Sum of Recursive Residuals (CUSUM) test and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) test (see Breusch, 1978; Breusch & Pagan, 1979; Brown, Durbin, & Evans, 1975; Godfrey, 1978; Ramsey, 1969). It is evident from the diagnostic tests, shown at the bottom of Table 2, that the coefficients are structurally stable, there are no problems of serial correlation or heteroskedasticity, and the functional form of the model is properly specified. A rejection of serial correlation and heteroskedasticity may not necessarily imply that the iid error term assumption holds. However, at least it provides some confidence in our results. We can therefore claim that the results are reliable and can be used for prediction purposes. Additionally, the estimated error correction term is negative and statistically significant, while the F-statistic indicates the presence of cointegration at a 5% significance level. The F-statistic is compared to Table CI(iii) Case III: Unrestricted intercept and no trend of Pesaran et al. (2001, p. 300) for three independent variables. This means that growth converges to its equilibrium level at a rate of 77.1% annually.

Let us now turn to the main results. In the short run, inflation uncertainty has differential effects on growth. That is, inflation uncertainty affects growth negatively in the current period but positively one-lag prior to this. Higher lags of inflation uncertainty do not matter for growth in the short run. In the long run, inflation uncertainty has a negative effect on growth. Similarly, inflation has a negative short-run effect on growth which is passed on as a long-run negative effect. From these results, it appears that inflation and inflation uncertainty may hurt growth both in the short and long run. This conclusion is in line with the Friedman-Ball

Table 2. Main Results

Lags	0	1	2			
Selected Model: ARDL (2, 0, 0, 2)						
Short-run						
Δ*ln*Y		0.236[1.804]				
ΔR	0.003[0.148]					
Δ*ln*INF	-0.018[-2.753]					
ΔVOL	-0.008[-2.296]	0.033[5.632]				
ECM(-1)	-0.771[-4.606]					
Long-run						
Constant	1.640[2.790]					
R	0.007[0.266]					
*ln*INF	-0.039[-2.090]					
VOL	-0.029[-2.256]					
Diagnostics						
Adj. R^2	F-statistic	RESET	LM	BPG	CUSUM	CUSUMSQ
0.656	5.516	1.845(0.181)	3.103(0.211)	1.643(0.149)	S	S

Note: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable.

hypothesis. According to Friedman (1977), higher levels of inflation are associated with higher inflation uncertainty. This inhibits the price mechanism and long-term contracting, which in turn slows down economic activities and growth. Ball (1992) agrees with this contention by demonstrating in a formal model that high inflation generates high inflation uncertainty which translates into even higher levels of future inflation, since the public will begin to doubt the credibility of the monetary authority. Our results are also in line with the existing findings. For example, Fischer (1993), Judson and Orphanides (1999), Bhar and Mallik (2013), and Heidari et al. (2013) found a negative impact of both inflation and inflation uncertainty on growth. The results, are slightly different from those presented by Grier and Grier (2006), who found that inflation does not affect growth inversely once inflation uncertainty is accounted for. They found that the negative impact of inflation on growth is indirectly linked to inflation uncertainty. In addition to the effects of inflation and inflation uncertainty, the results show that interest rate does not affect growth either in the short or in the long run.

Could it be that these results are influenced by the maximum lag restriction or our choice of the optimal lags for each variable using the AIC? Various studies have shown that the coefficient estimates of the ARDL specification are sensitive to lag restrictions and the optimal lag selection (Halicioglu, 2007; Iyke & Odhiambo, 2016; Tang, 2007). Therefore, we relaxed the restric-

Table 3. Results based on Lag Restriction from Two to Three

Lags	**0**	**1**	**2**	**3**		
Selected Model: ARDL (1, 0, 0, 3)						
Short-run						
Δ*ln*Y						
ΔR	0.001[0.071]					
Δ*ln*INF	-0.012[-2.525]					
ΔVOL	-0.011[-2.645]	0.039[5.928]	0.014[2.027]			
ECM(-1)	-0.728[-4.827]					
Long-run						
Constant	1.936[3.077]					
R	-0.004[-0.117]					
*ln*INF	-0.026[-2.658]					
VOL	-0.039[-2.531]					
Diagnostics						
Adj. R^2	F-statistic	RESET	LM	BPG	CUSUM	CUSUMSQ
0.656	5.990	2.039(0.160)	1.168(0.557)	1.661(0.126)	S	S

Note: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable.

tions in Table 2 in order to verify whether the results may change. First, we increased the maximum lag in the model from two to three and selected the optimal lags using the AIC. The resulting estimates following this adjustment are displayed in Table 3. The preferred specification here is ARDL (1, 0, 0, 3). From the diagnostic tests reported at the bottom of Table 3, it is obvious that the coefficients are structurally stable, there are no problems of serial correlation and heteroskedasticity, and the functional form of the model is properly specified. Although, the error correction term has been reduced slightly from -0.771 to -0.728, it is statistically significant, implying the convergence of growth to its equilibrium level annually. The calculated F-statistic also shows evidence in favor of cointegration in the model. These results are clearly reliable. Inflation uncertainty affects growth differentially in the short run by exerting a negative impact on growth in the current period, and a positive impact at one- and two-period lags. In the long run, inflation uncertainty is associated with falling growth. Inflation has both a short and a long-run negative impact on growth. These results are therefore very similar to those reported in Table 2.

In addition to adjusting the maximum lag in the model, we selected the optimal lags using the Schwarz information criterion (SIC) to verify whether the results in Table 2 will be affected. The estimated results following this adjustment are shown in Table 4. The preferred specification (i.e., ARDL (1, 0, 0, 2)) here is clearly different from the one shown in Table 2 (i.e.,

Table 4. Results based on selecting the Optimal Lags using SIC

Lags	**0**	**1**	**2**			
Selected Model: ARDL (1, 0, 0, 2)						
Short-run						
Δ*ln*Y						
ΔR	0.003[0.134]					
Δ*ln*INF	-0.015[-2.600]					
ΔVOL	-0.006[-1.904]	0.031[5.087]				
ECM(-1)	-0.576[-4.413]					
Long-run						
Constant	1.105[2.046]					
R	0.014[0.358]					
*ln*INF	-0.044[-2.945]					
VOL	-0.025[-2.505]					
Diagnostics						
Adj. R^2	F-statistic	RESET	LM	BPG	CUSUM	CUSUMSQ
0.632	5.197	2.262(0.177)	1.831(0.400)	1.696(0.146)	S	US

Note: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S and US denote stable and unstable, respectively.

ARDL (2, 0, 0, 2)). Additionally, the evidence in support of structural stability is not strong since the CUSUMSQ indicates instability. Nevertheless, the other diagnostic tests show that the results are reliable. There is also evidence in support of cointegration and convergence. Inflation uncertainty affects growth differentially in the short run, and negatively in the long run. Inflation affects growth adversely both in the short and long run. Again, these findings are fairly consistent with those reported in Table 2. Therefore, it is unlikely that the results are influenced by the maximum lag restriction and the choice of the optimal lags for each variable in the model.

Do decreases in inflation uncertainty have the same effects as increases? We explore this question by estimating Eq. (5). Following Iyke and Odhiambo (2015; 2016), we restricted the maximum lag to two and selected the optimal lag for each variable using the AIC. The results are reported in Table 5. The selected model is ARDL (2, 1, 0, 1, 2). The diagnostic tests, displayed at the bottom of the table, clearly suggest that these results are reliable. There is also evidence in support of cointegration and convergence. Note that the F-statistic in Table 5 is compared to Table CI(iii) Case III: Unrestricted intercept and no trend of Pesaran et al. (2001, p.300) for four independent variables. In

Table 5. Results based on the Nonlinear Specification

Lags	**0**	**1**	**2**			
Selected Model: ARDL (2, 1, 0, 1, 2)						
Short-run						
Δ*ln*Y		0.185[2.564]				
ΔR	0.045[1.959]					
Δ*ln*INF	-0.029[-2.043]					
ΔPOS	-0.043[-2.331]					
ΔNEG	-0.012[-5.091]	0.037[4.991]				
ECM(-1)	-0.795[-4.868]					
Long-run						
Constant	-0.122[-2.393]					
R	-0.022[-0.714]					
*ln*INF	-0.050[-2.385]					
POS	-0.029[-2.383]					
NEG	0.006[1.593]					
Diagnostics						
Adj. R-sq.	F-statistic	RESET	LM	BPG	CUSUM	CUSUMSQ
0.843	4.994	3.731(0.061)	1.439(0.486)	1.692(0.117)	S	S

Note: The values in the block parentheses are the t-statistics. P-values for the diagnostic tests are in the parentheses. S denotes stable.

the short run, increases in inflation uncertainty are associated with decreases in growth, while decreases are associated with differential responses of growth. In the long run, increases in inflation uncertainty affect growth negatively, while decreases have a positive but insignificant effect. What is clear is that in both the short and the long run, increasing inflation uncertainty is harmful for growth. A reduction in inflation uncertainty may reverse this pattern, but only slowly. Therefore, decreases in inflation uncertainty do not have the same impact as increases. With regards to the other variables, inflation has both a short and a long-run negative impact on growth, while the interest rate has a positive short-run impact on growth but a negative and insignificant impact in the long run.

In summary, the results presented above suggest that inflation uncertainty has differential effects on growth in the short run. In the long run, uncertainty has a negative effect on growth. These findings are generally consistent with the Friedman-Ball hypothesis and the findings of Fischer (1993), Judson and Orphanides (1999), and Bhar and Mallik (2013) for advanced economies. The results reflect the general performance of the Ghanaian economy during the entire period of 1963 to 2015, and specifically for the period of 1963 to 1985, when the country was under severe inflation uncertainty (see Figure 1). It is possible that the effect of inflation uncertainty may have lessened or dissipated in recent times due to moderate gains in stability. A good way to assess this is to break the sample into two: the period between 1963 to 1985 and the period after. However, since our data is annual, this will not be feasible. We suspect that the adverse economic conditions in the Euro Area and the US during 2007 to 2009 may have translated into heightened uncertainty in the country. The annualized measure of uncertainty does not adequately reflect this. The noise in this measure could possibly have masked the estimates, although, we do not expect the effect to be considerable. Another concern regarding our results is that they are likely to be induced by regime shifts in policies or structural changes. The stability test employed throughout the estimations suggest that regime shifts in policies or structural changes may not be driving our findings.

4. Conclusion

Inflation and inflation uncertainty are critical factors influencing the functioning of markets and thus the efficient flow of economic activities. Due to this, most central banks have been charged with the mandate of pursuing and maintaining low and stable inflation – the conviction being that low and stable inflation enhances information flow, capital formation, productivity and long-run growth. The issue has also attracted academic debates. The extant studies have used both low and high frequency data to assess the separate effects of inflation and inflation uncertainty on growth, and have come to mixed conclusions. However, recent studies have argued that the two factors are better studied jointly. The lack of high frequency data on developing countries implies that most of the studies on the joint effects of inflation and inflation uncertainty on growth have been largely skewed towards advanced economies and emerging market economies with sufficient data. This study does the opposite in pursuing the issue by focusing on a developing country, Ghana. This country has experienced prolonged periods of high and volatile inflation as shown in Figure 1, and therefore appears appealing for this empirical investigation. Unlike a majority of the extant studies, we separated out the short-run effects of inflation and inflation uncertainty on growth from the long-run effects. At the same time, we also examined whether increases in inflation uncertainty have the same effects on growth as do decreases in it. By applying linear and nonlinear specifications to a data set covering the period 1963 to 2015, we found that inflation has both short and long-run negative effects on growth. Inflation uncertainty has differential short-run effects and a negative long-run effect on growth. Increases in inflation uncertainty hurt growth, while decreases may reverse this pattern but only slowly. Both inflation and inflation uncertainty are critical determinants of growth in the country. To promote growth, policymakers should continue to pursue a low inflation target, while ensuring minimum inflation uncertainty. Further studies need to be undertaken to make this policy implication more concrete.

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Endnotes

1 *One of the reviewers provided us this insight.*

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