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THE INFLATION-GROWTH RELATIONSHIP IN SSA INFLATION-TARGETING COUNTRIES

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Abstract
This paper investigates the relationship between inflation and economic growth for South Africa and Ghana using quarterly empirical data collected from 2001 to 2016 applied to the quantile regression method. For our full sample estimates we find that inflation is positively related with growth in Ghana at high inflation levels whilst inflation in South Africa exerts its least adverse effects at high inflation levels. However, when particularly focusing on the post-crisis period, we find inflation exerts negative effects at all levels of inflation for both countries with inflation having its least adverse effects at high levels for Ghana and at moderate levels for South Arica. Based on these findings bear important implications for inflation targeting frameworks adopted by Central Banks in both countries.

1. Introduction

The effects of inflation on economic growth represent one of the most studied phenomenons in the macroeconomic paradigm. The importance of inflation as a macroeconomic variable in the literature arises from its ability to reflect the efficiency and effectiveness of monetary policy in influencing the macroeconomy. In particular, the extent to which inflation affects output growth or economic performance has proven to be a topic of substantial relevance to any Central Bank concerned with price stability. From a policy perspective, attainment of a low and stable inflation can be unambiguously described as the fundamental objective of monetary policy authorities worldwide since it is widely believed that inflation exerts

adverse effects on macroeconomic variables like investment, output and productivity. Generally, the available empirical evidence, tends to, more often than not, lend support to the notion that inflation is detrimental to economic growth and that price stability, defined as a low and stable inflation rate, is at least an important condition for the attainment of economic growth. At the broadest level, the literature clearly supports the notion that well-run and well-governed Central Banks with strong and efficient productive structures tend to simultaneously exhibit both low inflation rates and high economic growth.

Since 1990, when the Bank of New Zealand became the first Central Bank to adopt an inflation targeting framework, the number of Central Banks operating under a similar policy framework has steadily increased. Within the design of an inflation targeting framework, monetary authorities aim to keep inflation below a defined level; reduce bank support for government deficits; help manage the country's integration into world trade and financial markets and vigorously reduce the influence of democratic social and political forces on Central Bank policy (Phiri, 2016a). Moreover the inflation targeting framework has proven to be virtuous in curbing inflation and lowering inflation volatility in addition to being built on fundamental pillars such as credibility, transparency, independence and accountability (Phiri, 2016b). Despite these noteworthy attributes of inflation targeting frameworks, the popularity of the inflation targeting framework appears to be restricted to industrialized economies especially when considering that only two Central Banks in African countries have adopted fully-fledged inflation targeting frameworks, those being, the South African and Ghanaian monetary authorities.

The global financial crisis of 2007-2008 as orchestrated by the bursting of the US housing market bubble in August 2007 eventually led to the collapse of the US financial sector following the closure of large US investment firms which ultimately exacerbated into the global financial crisis via contagion effects. As a result of the financial crisis, the world economy faced an economic downturn in which world GDP growth rates plummeted from over 4 percent in early 2007 to below 0.5 percent in late 2008 whereas inflation rates steadily increased from 4.4 percent in 2006 to over 9 percent in 2009. Since then most economies worldwide are still attempting to recuperate from the aftermath of the sub-prime crisis both in terms of lowering inflation rates as well as improving economic growth levels. In wake of the global financial crisis, the inflation targeting regime has come under considerable scrutiny and criticism since it is widely argued/believed that the framework strictly focuses on the attainment of low and stable inflation through manipulation of short term interest rates at the expense other competing macroeconomic objectives such as financial and macroeconomic stability.

From an academic point of view, it is highly probable that the global financial crisis has caused a shift in the inflation-growth relationship previous established by other authors. For instance, recent empirical evidence has revealed that the global financial crisis caused changes in monetary relationships such as the exchange rate pass-through dynamics (Kabundi and Mbelu, 2016), between the US Federal fund rate and stock market volatility (Phiri, 2016c) as well as in inflation persistence (Phiri, 2017). However, up-to-date, there exists no empirical attempts, to the best of our knowledge, which has looked as the possibility of the global financial crisis causing a change in the inflation-growth relationship. Highly motivated by this hiatus, in this present study, we examine the relationship between inflation and economic growth for

South Africa and Ghana in light of the global financial crisis. We consider these countries since they are representative of inflation targeting countries in the Sub-Saharan Africa (SSA) region. Therefore a study of this nature is more relevant towards monetary authorities in these countries since the obtained empirical results can be used as benchmark for directly evaluating the appropriateness of inflation targets towards economic growth in these economies. We also note that previous studies may have unable to perform a similar analysis based on the unavailability of a suitable length of time series data. However, we are currently celebrating the 10th anniversary since the infamous sub-prime crisis hence ensuring that quarterly data would be sufficient enough to carry out an analysis of this magnitude.

Of recent there has been a increasing dissatisfaction with the conventional view of a linear relationship between inflation and growth, and the literature is rather advocating for a non-monotonic relationship (Chu et al. (2017), Oikawa and Ueda (2018), Ibarra and Trupkin (2016), Ndoricimpa (2017), Omay et al. (2018)). In our study, we make consideration of a nonlinear inflation-growth relationship for South Africa and Ghana by methodologically relying on the quantile regression framework of Koenker and Bassett (1978). In differing from other nonlinear econometric models found in the literature such as the threshold autoregressive (TAR), the smooth transition regression (STR) and the Markov Switching (M-S) models which tend to impose a singular or double threshold within the estimated regressions, quantile regression provide the advantage of examining the effects the dependent variable at many points of conditional distribution thus providing a more complete picture of relationship between the target variable and its covariates. Moreover, unlike other econometric models which can be inefficient if the standard errors are highly non-normal, quantile regressions are more robust to non-normal errors and outliers (Koenker and Bassett, 1978). As part and parcel of our empirical strategy, we perform our quantile regressions on two data sets, the first corresponding to the pre-crisis period and the second corresponding to the post-crisis period.

Against this background, we structure the remainder of the paper as follows. The next section provides an overview of inflation targeting in South Africa and Ghana. The third section of the paper presents the literature review whilst the fourth section puts the data and methodology into perspective. The empirical analysis is carried in section five of the paper whereas the paper is concluded in the sixth section of the paper.

2. An overview of inflation targeting in South Africa and Ghana

As previously mentioned, the Bank of New Zealand became the first Central Bank to adopt an inflation targeting regime in 1990, with other Central Banks in Chile (1990), Canada (1991), Israel (1991), the UK (1992), Sweden (1993), Finland (1993) and Austria (1994) following closely in pursuit. However, the popularity of the inflation targeting framework gained prominence subsequent to the Asian financial crisis of 1997-1998 and in particular following the recommendations of the International Monetary Fund (IMF) in their advocacy for monetary authorities worldwide to adopt a combination of flexible exchange rates and inflation targets (Phiri, 2012). Notably, it was shortly after this period that the South African Reserve Bank (SARB) become the first African economy to announce the intention to adopt an inflation targeting framework as an official monetary policy mandate in 2000 whilst the Bank of

Ghana (BOG) undertook such a decision in 2002. Nevertheless, the SARB began to official implement inflation targeting in February 2002 whereas the BOG decided to do so in May 2007 barely months before the infamous bankruptcy filing of the Lehman Brothers which was a catalyst factor in the ensuing global financial crisis.

Inflation targeting frameworks as adopted by both the SARB and the BOG are guided by statutory mandates and in particular the SARB act No. 90 of 1989 as well as the BOG Act 612 (2002), respectively. Prior to adopting inflation targeting frameworks both Central Banks were dependent on money supply growth guidelines which were deemed ineffective due to the weakened relationship between inflation and money supply. Consequentially, both Central Banks gradually developed the institutional capacity necessary for implementing the inflation targeting regime, and during this transition period these Central Banks moved away from the traditional monetary policy framework that was focused on targeting a monetary aggregate, towards analysing a broader range of indicator to assess its monetary stance (Kovanen, 2011). However, subsequent to the decision to directly target inflation, both Central Banks abandoned their partial or informal inflation target regimes in favour of formal inflation targets of 3 to 6 percent as set by the SARB, whilst the BOG adopted a set target of 8 percent which is allowed to deviate 2 percent above or below this target point (i.e. therefore establishing an inflation targeting range of between 6 and 10 percent). For the case of both Central Banks, the appointed monetary policy committee (MPC) acts in conjunction with the Ministry of Finance in setting the inflation targets and ultimately bears the responsibility for ensuring that inflation remains within the set target and does so via the manipulation of short term interest rates i.e. repurchase or repo rate.

3. Literature review

3.1. Exposition of the theoretical review

Dynamic growth models were formally introduced into the literature mainly as a courtesy of Harrod (1939) and Domar (1946). Dissatisfied with the conventional systematic thinking associated with static theory, the authors developed a dynamic system of economic axioms in which *certain forces* are operating steadily to increase or decrease certain magnitudes in the system (Solow, 1965). Equilibrium in such a system is not static but can rather be thought of as a moving equilibrium. Along such equilibrium, growth occurs such that it leaves all parties satisfied, that is, they will choose to remain on the same path of output, *ceteris paribus.* However, growth along such a path is highly unstable as compared to the case of static growth. In the latter case, equilibrium is assumed to exhibit self-correcting tendencies in the sense that any diversion from static equilibrium will, through certain adjustment processes, lead back to equilibrium. In the case of a moving equilibrium, departure from the equilibrium does not necessarily result in '*invisible forces*' causing a return to equilibrium as dictated by the laws of demand and supply but could result in a further diversion from the established equilibrium growth path (Mankiw, Romer and Weil, 1992).

The next paradigm into the analysis of dynamic long-run economic growth came courtesy of neo-classical economists whom have seemed to have dominated the exposition. A major contribution by neo-classical growth economics is the distinction of different growth factors; namely capital accumulation or gross fixed

capital formation, growth in the labour force and technological progress as well as being able to incorporate functioning pricing systems into dynamic economic growth models (Gokal and Hanif, 2004). The introduction of these pricing systems allowed for the analysis of the effects of inflation on economic growth using monetary assets and capital accumulation as the primary channel mechanism between inflation and real activity in the economic (Frenkel and Rodriguez, 1975). In a separate seminar papers, Mundell (1963) and Tobin (1965) incorporated the role of money within the neo-classical growth model by designating money as a store of value. Within the aforementioned models, inflation causes individuals to substitute away from physical money to interest earning monetary assets which leads to higher capital accumulation and higher economic growth hence insinuating a positive inflation-growth relationship.

By relying on a monetary optimizing growth model in which infinite lived agents optimize an intertemporal utility function, Sidrauski (1967) challenged Tobin's (1965) proposition by insinuating that increase in money supply and hence inflation will increase per capita money balances whilst exerting no effect on per capita consumption and capital accumulation levels. This non-effect of an increase of money supply on capital accumulation and ultimately economic growth is what is more popularly dubbed as the superneutrality hypothesis of money. Stockman (1981) developed a neo-classical model with inelastic labour supply in which money is a complimentary to capital and is held to satisfy a cash-in-advance constraint. Inflation, which is induced by an increase in money supply growth, exerts a long-run negative effect on economic growth if money held satisfies the cash-in-advance constraints, otherwise money is superneutral. Greenwood and Huffman (1987) as well as Cooley and Hansen (1989) extended on Stockman (1981) by assuming there exists a labour-leisure choice/trade-off in which inflation increase leisure (non-productive) which ultimately drives down economic growth although Greenwood and Huffman (1987) find a direct effect from leisure to economic growth whereas Cooley and Hansen (1989) establish an indirect channel via capital accumulation.

Following the neoclassical era, came the construction of a class of growth models in which the key determinants of growth were endogenous to the model. These new growth theories or endogenous growth models introduced a new analytical paradigm that departed in a significant way from neo-classical economies. In particular, economic growth within endogenous growth models through factors within the production process such as; economies of scale, increasing returns or induced technological change; in contrast to exogenous factors such as population growth increases (Solow, 1994). The studies of Lucas (1982), Svensson (1985) and Lucas and Stokey (1987) represent blueprint works which depict the negative effect inflation within an endogenous growth model whereby inflation acts as a tax on the return to all forms of capital and ultimately economic growth. Furthermore, these endogenous models are responsible for the emergence of dynamic nonlinear effect of inflation on growth, with the study of Gillman ad Kejak (2004) being amongst the first to depict such a nonlinear relationship in which the Tobin effect (i.e. positive inflation-growth relationship) is found at low levels, whereas at higher levels the negative Stockman effect comes into play. The models main attribute is the ability for the representative agent to choose between two competitive mechanism, money and credit and an increased use of credit such that an initial increase in marginal cost of money (i.e. inflation) causes an initial increase in the return to capital which later

turns negative hence dictating the nonlinear inflation-growth relationship. Moreover, other theoretical studies presented by Huybens and Smith (1999) and Bose (2002). Low inflation does not distort information or interfere with resource allocation and economic activity up to certain inflation threshold of which crossed, inflation aggravates the credit market through distorted flow of information.

3.2. Empirical review of associated literature

To the say the least, there has been a prolific amount of empirical evidence on the inflation-growth nexus. For the sake of brevity and relevance, we restrict our review of the associated literature to the studies which include South African and Ghanaian data in their empirical analysis, which still represents an exhaustive portion of the available empirical literature. Moreover, these studies can be conveniently disintegrated into five strands of empirical works, namely; i) panel studies inclusive of both South African and Ghanaian data ii) Panel studies which only include South African data iii) Panel studies which only include Ghanaian data iv) Country-specific South African studies v) Country-specific Ghanaian studies. The first cluster of studies are inclusive of the panel works of Fischer (1993), Sarel (1996), Bruno and Easterly (1998), Khan and Senhadji (2001), Gylfason and Herbertsson (2001), Rousseau and Wachtel (2002), Burdekin et al. (2004), Drukker et al. (2005), Li (2006), Pollin and Zhu (2006), Vaona and Schiavo (2007), Espinoza et. al. (2010), Bick (2010), Jude (2010), Mignon and Villavicencio (2011), Eggoh (2012), Kremer et. al. (2013), Mahawiya (2015), Ibarra and Trupkin (2016) and Ndoricimpa (2017). Notably most of these studies discard the notion of a linear inflation-growth relationship for the countries under investigation implying that inflation has different effects on economic growth depending on the level of inflation. Closely associated with this idea is the concept of an inflation threshold which represents the optimal level of inflation which maximizes economic growth.

In further summarizing the results of this first group of studies we observe that Fischer (1993), Barro (1995) and Bruno and Easterly (1998) find that inflation only significantly and negatively affects economic growth at very high levels of inflation (i.e. above 40 percent); Sarel (1996) estimates a specific 8 percent threshold; Khan and Senhadji (2001) find an 11-12 percent inflation threshold; Gylfason and Herbertsson (2001) 20-30 establish a percent inflation threshold; Rousseau and Wachtel (2002) find a 13-25 percent threshold; Burdekin et al. (2004) estimate the inflation threshold to lie between 20 and 30 percent; Drukker et al. (2005) find a 19.16 percent threshold; Li (2006) establishes two inflation thresholds points at 14 and 38 percent in which inflation has an insignificant effect in the lower regime and turns significantly negative in the middle regime before exhibiting diminishing marginal negative effects in the third regime; Pollin and Zhu (2006) find a 5-18 percent threshold; Vaona and Schiavo (2007) estimate a 5-6 percent inflation threshold; Espinoza et. al. (2010) find a 10 percent threshold; Bick (2010) estimate an inflation threshold at 19.16 percent; Jude (2010) finds two inflation thresholds of 9.5 and 24 percent which the adverse effects of inflation on economic growth strengthens as one moves from the lowest regime to the highest regime; Mignon and Villavicencio (2011) find a 19.6 percent inflation threshold; Eggoh (2012) finds an inflation threshold of 10-20 percent; Kremer et. al. (2013) establish a 17 percent threshold; Mahawiya (2015) find a 17.9 percent for ECOWAS countries (including

Ghana) and 14.5 percent for SADC countries (including South Africa); Ibarra and Trupkin (2016) find a 19.1 percent inflation threshold whilst Ndoricimpa (2017) estimate a 6.7 percent inflation threshold

Under the second group of studies, those being panel studies which only include South Africa in the empirical analysis, the available studies can be narrowed down to the works of Seleteng et al. (2013), Bittencourt et al. (2015), Behera and Mishra (2016) and Manamperi (2014). Note that whilst the works of Manamperi (2014), Bittencourt et al. (2015) and Behera and Mishra (2016) all assume linear empirical frameworks, on the other hand, the study of Seleteng et al. (2013) applies a nonlinear empirical framework (smooth transition regression model). In particular, Manamperi (2014) find a negative inflation-growth relationship in the short-run and no significant relationship over the long-run; Bittencourt et al. (2015) establish a long-run negative inflation-growth relationship; Behera and Mishra (2016) find a positive relationship for South Africa in the short-run which turns positive in the long-run whereas Seleteng et al. (2013) estimate an inflation threshold of 18.9 percent. Conversely, for the third group of studies which are panel studies inclusive of Ghana, the studies of Ahortor et al. (2010), Danladi (2013) and Iyke and Odhiambo (2017) are prominent examples and notably all aforementioned studies are nonlinear studies. Ahortor et al. (2010) estimate a 10 percent inflation threshold; Danladi (2013) find a 9 percent inflation threshold and Iyke and Odhiambo (2017) find a double threshold of 10.73 and 29.83 percent for Ghana where there exists a positive in first regime and second regimes and negative in third regime.

The fourth and fifth cluster of studies reviewed represent country-specific or individual studies for South Africa and Ghana, respectively. The South African country-specific studies include the linear studies of Hodge (2006); Odhiambo (2013) and Munyeka (2014) as well as the nonlinear works of Nell (2000); Phiri (2010); Leshoro (2012); Adusei (2012) and Phiri (2013). Nell (2000) finds that inflation within the singe-digit region/zone is beneficial for economic growth; Hodge (2006) establish a negative long-run inflation-growth relationship; Phiri (2010) estimates a 8 percent threshold; Leshoro (2012) finds a 4 percent threshold; Adusei (2012) finds a 7 percent threshold; Odhiambo (2013) find a negative short run and long-run inflation-growth relationship with bi-variate causality between the two variables; Phiri (2013) estimates a 3.08 percent inflation thresholds whereas Munyeka (2014) find a negative inflation-growth relationship. On the other end of the spectrum, the country-specific Ghanaian studies include the studies of Frimpong and Oteng-Abayie (2010); Quartey (2010); Marbuah (2011); Mireku (2012); Ayisi et al. (2013) and Enu et al. (2013) and notably all reviewed studies are nonlinear studies with the exception of the works of Enu et al. (2013) and Ahiakpor and Akapare (2014). Specifically, Frimpong and Oteng-Abayie (2010) estimate an 11 percent threshold; Quartey (2010) find a 22.2 percent inflation threshold; Marbuah (2011) establishes a 10 percent inflation threshold for Ghana; Mireku (2012) estimates a 9 percent inflation threshold level; and Ayisi et al. (2013) finds a 21 percent inflation threshold. On the other hand, both Enu et al. (2013) and Ahiakpor and Akapare (2014) uncover a negative and linear relationship between inflation and growth in Ghana.

4. Methodology

Empirical studies assessing the impact of inflation on economic growth typically assumes the following econometric framework:

$$Y_t = \beta X_t + e_t \tag{1}$$

Where Y_t is the per capita GDP growth rate, X_t represents a vector of explanatory variables and e_t is a well-behaved error term. We particularly specify our vector of explanatory variables as:

$$X_t = \{inf_t, inv/gdp_t, gov/gdp_t, m3/gdp_t, pop_t\} \tag{2}$$

Where inf_t is the inflation rate, inv/gdp_t is a measure of domestic investment, gov/gdp_t is a measure of government size, $m3/gdp_t$ is a measure of monetary depth and pop_t is the population variable. In further elaborating on this explanatory variable, we note firstly note that the inflation represents our main/primary explanatory variable and according to economic theory can either exert a negative or positive effect on economic growth. The second conditioning variable is the investment variable and is according to conventional growth theory is expected to exert a positive effect on economic growth. In this regard, it is well known from the Neoclassical and endogenous growth theories, that investments are the engine of economic growth. The third conditioning variable, which is government size, is regarded as having a positive effect on economic growth as is a stylized feature of Wagner's law and it's rudiment theories. The fourth variable, the monetary depth variable is and this assumption comes courtesy of Schumpeter (1912) who was among the first to theoretical hypothesize on a positive effect of financial depth on economic growth. The last conditioning variable is population growth which according to traditional growth theory should exert a positive effect on economic growth. In estimating regression (1), traditional OLS estimates can be obtained by the finding the vector β_t which minimizes the sum squares residuals (SSR) i.e.

$$\min_{\beta \in \mathscr{A}^k} \left[\sum_{i \in \{i : y_i \geq x_i \beta\}} (y_i - x_i'\beta)^2 \right] \tag{3}$$

However, as previously mentioned our empirical analysis deviates from the traditional OLS methodology and opts to apply/rely on quantile regression estimators. The quantile regression methodology is basically a straightforward extension of the mean absolute deviator (M.A.D):

$$\min_{\beta \in \mathscr{A}^k} \left[\sum_{i \in \{i : y_i \geq x_i \beta\}} /y_i - x_i'\beta / \right] \tag{4}$$

Of which the above M.A.D. estimator can be re-specified as:

$$\min_{\beta \in \mathscr{A}^k} \left[\sum_{i \in \{i : y_i \geq x_i \beta\}} \tau /y_i - x_i'\beta / + \sum_{i \in \{i : y_i \geq x_i \beta\}} (1 - \tau) /y_i - x_i'\beta / \right] \tag{5}$$

Where τ is the τth quantile and set at ½ in order to obtain the MAD estimator. The main idea behind the quantile regression estimates is to use varying values of τ bound between 0 and 1 (i.e. $\tau \in 0,1$) hence producing a cluster of regressions which traces the entire distribution of the regressor conditional on the regressand. The quantile coefficients can be interpreted as the marginal change in the regressand variable due to a marginal change in the regressor variable conditional on being on the τth quantile. In our study, we particularly employ three quantiles with intervals of 0.25 between the quantile (i.e. = 0.25, 0.50 and 0.75) hence resulting the following empirical conditional mean functions:

$$\min_{\beta \in \mathscr{A}^k} \left[\sum_{i \in \{i : y_i \geq x_i \beta\}} 0.25 /y_i - x_i'\beta / + \sum_{i \in \{i : y_i \geq x_i \beta\}} 0.75 /y_i - x_i'\beta / \right] \tag{6}$$

$$\min_{\beta \in \mathfrak{R}^k} [\Sigma_{i \in \{i: y_i \geq x_i'\beta\}} \, 0.5 / y_i - x_i'\beta / + \Sigma_{i \in \{i: y_i \geq x_i'\beta\}} \, 0.5 / y_i - x_i'\beta /] \qquad (7)$$

$$\min_{\beta \in \mathfrak{R}^k} [\Sigma_{i \in \{i: y_i \geq x_i'\beta\}} \, 0.75 / y_i - x_i'\beta / + \Sigma_{i \in \{i: y_i \geq x_i'\beta\}} \, 0.25 / y_i - x_i'\beta /] \qquad (8)$$

Equations (5) though (8) can be solved straightforward using traditional linear programming techniques.

5. Data and empirical results

5.1. Data description and preliminary analysis

Our empirical study employs annual time series data collected from the World Bank online statistical database spanning over a 46 year period of 1970 to 2016. For the sake of empirical rigorousness, we choose to interpolate the data into quarterly data hence yielding empirical data spanning over a period of 1970:q1 to 2016:q4. In particular, our dataset consists of the annual percentage change in gross domestic product (i.e. gdp), the percentage change in consumer inflation price (i.e. inf), broad money expressed as a percentage of GDP (i.e. M3/GDP), gross domestic fixed capital expressed as a percentage of GDP (i.e. inv/gdp), government expenditure expressed as a percentage of GDP (i.e. gov/gdp), the population growth (i.e. pop) and the percentage growth in terms of trade (i.e. trade). As a preliminary step in our empirical process, we begin by examining the basic descriptive statistics of the time series variables as well as their correlation matrix for both economies as reported in Tables 1 and 2, respectively. Moreover, the time series plot for all employed time series variables are reported in Figure 1 and 2 respectively.

From the descriptive statistics we note a number of interesting statistics such as the inflation averages 30.26 and 9.37 for Ghana and South Africa, respectively, with both averages exceeding their designated inflation targets assigned by monetary authorities in both countries. Nevertheless, the computed standard deviations indicate relatively high variation for Ghanaian data over the full sample time period, whereas South African inflation appears to not be as volatile as Ghanaian inflation. We also note the low economic growth averages of 3.71 and 2.53 for Ghanaian and South African data, respectively and the growth average for the latter country is well below the 6 percent long-term target. The corresponding standard deviation for economic growth is higher than the mean for Ghana yet lower than the mean for South Africa. This observation implies that Ghanaian growth rates are more susceptible to negative values compared to South African counterpart. Also note the reported Jarque-Bera statistics which indicate a case of non-normality for a number of the time series in both countries, an observation which strengthens the case in favour of the use of quantile regression methodology.

On the other end of the spectrum, the correlation matrices for both countries mutually display negative correlations between inflation and growth, an observation consistent with conventional growth theory. However, the correlation coefficients between growth and other determinants produce contradictory results for South Africa, noticeably for the negative coefficients between economic growth and investment, government size as well as population growth. On the other hand, concerning Ghanaian data, it appears that all signs produced by correlation coefficients

between economic growth and the growth determinants remains consistent with growth theory. We also note that all correlation coefficients are bound between the values of 0.01 to 0.82 for both countries hence providing strong preliminary evidence on the absence of heteroscedasticity between the variables. We therefore proceed to present the empirical results of the quantile regression estimates.

Table 1. Summary statistics and correlation matrix for Ghanaian data

	gdp	inf	inv/gdp	gov/gdp	m3/gdp	pop	trade
mean	3.71	30.26	16.68	12.02	36.10	2.58	57.69
std. dev.	4.50	27.95	7.89	3.19	14.14	0.38	30.14
jb	29.54	65.53	3.33	9.55	1.12	2.73	2.68
p-value	0.00	0.00	0.19	0.01	0.57	0.26	0.26
gdp	1						
inf	-0.16	1					
inv/gdp	0.43	-0.51	1				
gov/gdp	0.10	-0.36	0.61	1			
m3/gdp	0.02	0.42	-0.21	-0.28	1		
pop	0.05	-0.10	-0.22	-0.46	0.03	1	
trade	0.41	-0.51	0.82	0.50	-0.18	-0.24	1

Figure 1. Time series plot for Ghana
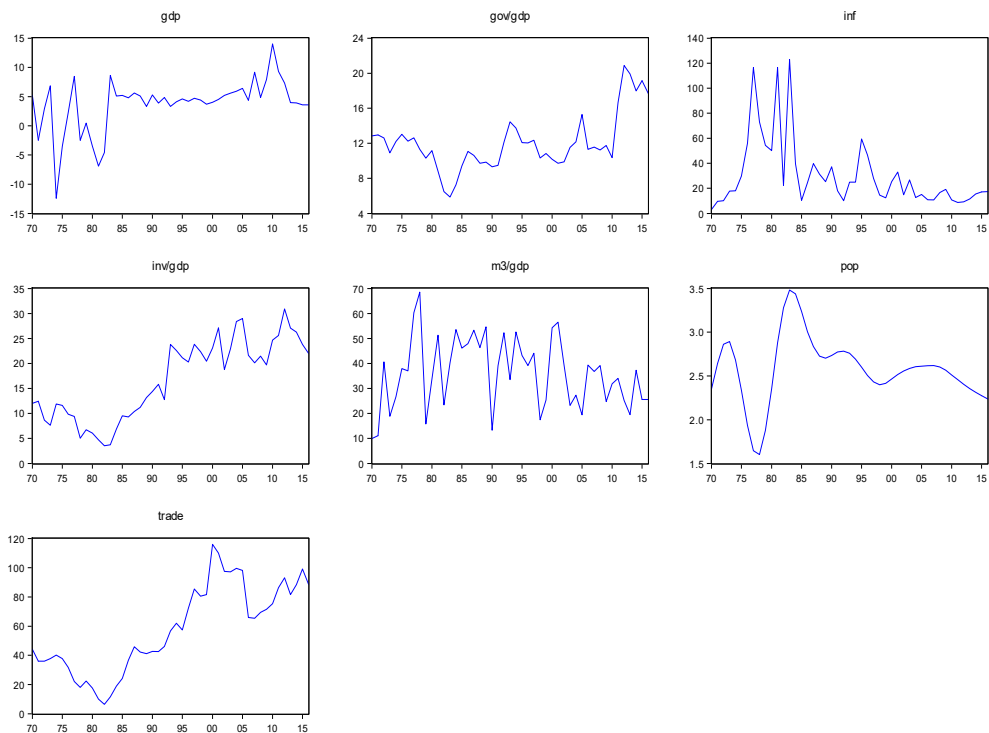
Table 2. Summary statistics and correlation matrix for South African data

	gdp	inf	inv/gdp	gov/gdp	m3/gdp	pop	trade
mean	2.53	9.37	21.79	17.21	59.43	1.99	52.40
std. dev.	2.24	4.19	4.91	2.91	9.54	0.55	7.74
jb	1.76	2.40	3.75	5.98	5.70	4.94	0.36
p-value	0.41	0.30	0.15	0.05	0.06	0.08	0.83
gdp	1						
inf	-0.33	1					
inv/gdp	-0.01	0.44	1				
gov/gdp	-0.25	-0.32	-0.82	1			
m3/gdp	0.11	-0.54	-0.05	0.30	1		
pop	-0.13	0.63	0.70	-0.73	-0.59	1	
Trade	0.29	-0.22	0.16	0.09	0.75	-0.47	1

Figure 2. Time series plot for South Africa
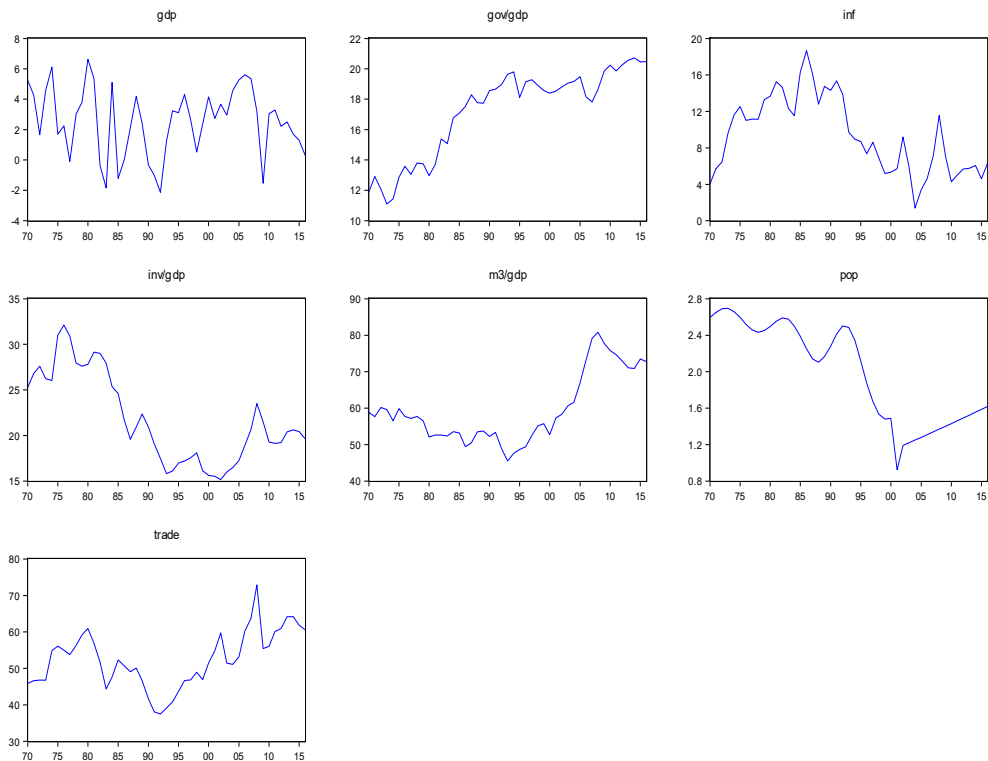
5.2. Regression estimates

Table 1 below reports the full sample empirical results for the quantile regressions for both Ghanaian and South African data. Starting with the results for Ghanaian data, we firstly observe that the inflation coefficient produces a negative and significant coefficient at low quantiles, insignificant at medial quantiles and

positive at high quantiles. We note a similar nonlinear finding in the study of Fisher (1993) Barro (1995) and Bruno and Easterly (1998), who all argue that inflation exerts its most adverse effect on growth at very high levels of inflation. At face value these results particularly insinuate that Ghanaian monetary authorities should consider allowing their inflation target to drift to higher levels in the interest of encouraging economic growth. However, for the investment variable, we note a positive and significant estimates at lower quantiles whereas the coefficient turns insignificant at other quantiles. We observe that this finding bridges two opposing findings that being the insignificant effect of investment on growth in Ghana as found in Ahortor et al. (2014) and Nketiah-Amponsah (2009) as well as the positive effect of investment of Ghanaian growth as reported in Frimpong and Oteng-Abayie (2010).

Concerning the monetary depth and government size variables, we find insignificant effects across all quantile distributions. This finding between the former variable and growth is quite surprising since a number of studies have theoretically and empirically advocated for a positive relationship between money supply and GDP (Khabo and Harmse, 2005). However, we are quick to note that such empirical evidence of an insignificant relationship between monetary depth and economic growth has been previously provided for in the study of Marbuah (2011) and Adu et al. (2013). However, the finding of an insignificant effect of government size on economic growth across different quantiles is puzzling finding and may plainly reflect the ineffectiveness of Ghanaian fiscal policy in stimulating domestic growth. Similar empirical evidence for Gahan has been found in the study of Adusei (2013). Finally, for the population variable, we only find a positive and statistically significant values at the 50th and 75th quantiles whilst for terms of trade we only obtain a positive and significant coefficient at the 50th quantile. These last two findings are consistent with traditional economic theory which advocate for a positive effect of these variables on economic growth which has been previously empirical depicted for in the studies of Frimpong and Oteng-Abayie (2010) as well as Ahortor et al. (2014).

On the other end of the spectrum, from the results associated with the South African data, we first and foremost report a negative and statistically significant inflation coefficient across all quantiles with the least adverse effects of inflation being realized at moderate inflation levels (i.e. 50th quantile). Note that this finding is consistent with that obtained in the work of Hodge (2006) and Adusei (2012) for similar South African data. Similarly, the domestic investment and government size variables produce negative coefficients which are significant at all critical levels across all quantile levels whilst the financial deepening variable also produces negative coefficients across all quantiles albeit being only statistically significant at high quantiles (i.e. 75th quantile). We note that Phiri (2017) finds a similar negative investment-growth relationship, which is advocated to lack of Greenfiled investment and crowding out effects of public spending and budget deficits whilst the negative government spending-economic growth relationship has been previous found in Chipaumire (2014) for South African. Finally, the population and terms of trade variables produce positive coefficients and yet these are only statistically significant at a 5 percent critical level at the 25th and 75th quantiles for the former variable whereas the coefficients are statistically significant at all critical levels across all quantiles. For the later variable, we deem these results as being plausible since it adheres to conventional growth theory which hypothesizes that both human capital and trade openness are catalysts for economic growth.

Table 3. Full sample quantile estimates

	Ghana				South Africa		
	0.25	0.50	0.75		0.25	0.5	0.75
c	-1.27	-7.54	-4.38		14.03	16.56	16.21
	(0.81)	(0.00)***	(0.29)		(0.00)***	(0.00)***	(0.09)*
inf	-0.06	0.01	0.03		-0.21	-0.19	-0.24
	(0.00)***	(0.28)	(0.04)*		(0.00)***	(0.00)***	(0.00)***
inv/gdp	0.27	0.07	0.07		-0.65	-0.56	-0.44
	(0.03)**	(0.11)	(0.56)		(0.00)***	(0.00)***	(0.00)***
M3/gdp	0.03	-0.02	0.01		-0.04	-0.03	-0.10
	(0.33)	(0.24)	(0.93)		(0.21)	(0.40)	(0.00)***
gov/gdp	-0.17	-0.05	0.09		-0.90	-0.82	-0.65
	(0.13)	(0.31)	(0.55)		(0.00)***	(0.00)***	(0.00)***
pop	0.40	3.70	2.29		2.77	1.88	1.21
	(0.83)	(0.00)***	(0.09)*		(0.00)***	(0.06)*	(0.52)
trade	0.01	0.03	0.01		0.30	0.23	0.26
	(0.71)	(0.03)**	(0.68)		(0.00)***	(0.00)***	(0.00)***

Notes: "***", "**", "*" represent 1 percent, 5 percent and 10 percent significance levels, respectively. p-values reported in parentheses.

5.3. Sensitivity analysis

It is very possible that our empirical results obtained from our full sample estimates thus far exhibit a substantial degree of inaccuracy when primarily considering that the full sample period encompasses important structural breaks, most notably the global financial crisis of 2007 which stands out as the singular most catastrophic global financial downturn/meltdown since the great depressions. This event necessitates the need to test the sensitivity of our empirical estimates to structural breaks which is pragmatically performed by splitting the time series data for both countries into two sub-samples corresponding to the pre-crisis and post-crisis periods and provide quantile estimates for the sub-samples for both countries as reported in Tables 4 and 5, respectively below. We note that a vast majority of the estimated results obtained from the pre-crisis period are coherent with those previously obtained from the full sample estimates for both countries. However, with respect to the post-crisis period, the obtained results differ from those of the pre-crisis and full sample estimates for a number of key relationships.

For instance, during the post-crisis period in Ghana, inflation produces negative and statistically significant values across all quantiles with the least adverse effects of inflation being established at the upper quantile. We further note significant changes in the monetary depth and government size variables coefficients for Ghana as they are mutually insignificant across al quantiles in the pre-crisis and turning negative and statistically significant throughout all quantiles in the post-crisis period. Similarly the coefficients on the population growth variable for the same country are statistically significant and positive only at the 50th and 75th quantile in the pre-crisis whilst being significant and negative in the 25th quantile in the post-crisis. Finally, we observe a slight change in the terms of trade coefficient as they become positive and statistically significant at all levels of significance across all quantile levels during the post-crisis period.

For the case of South Africa, there is not much change in the inflation-growth relationship between the pre and post crisis periods particularly concerning

the coefficient sign and statistical significance. However, we note changes in the magnitude of the relationship in which the least adverse effects of inflation on growth in the post crisis are now established at moderate levels. Similarly, for other coefficients like investment, monetary depth and government size, there is no change in the coefficient signs except the statistical significance differ between pre and post crisis periods. The only major change in coefficient sign occur with the population growth variable which turns from positive and statistically significant at all critical levels across all quantiles in the pre-crisis and turning positive and statistically significant across all quantiles in the post-crisis.

Table 4. Pre-and-post crisis quantile estimates: Ghana

	Pre-crisis				Post-crisis		
	0.25	0.50	0.75		0.25	0.50	0.75
c	2.18	-8.48	-7.75		36.96	3.47	4.88
	(0.76)	(0.00)***	(0.06)*		(0.00)***	(0.80)	(0.67)
inf	-0.06	0.02	0.04		-0.77	-0.50	-0.47
	(0.01)**	(0.20)	(0.00)***		(0.00)***	(0.00)***	(0.00)***
inv/gdp	0.39	0.04	-0.05		0.23	0.26	0.20
	(0.08)*	(0.54)	(0.45)		(0.06)*	(0.00)***	(0.10)
M3/gdp	0.03	-0.02	-0.02		-0.08	-0.10	-0.13
	(0.32)	(0.26)	(0.31)		(0.02)**	(0.00)***	(0.00)***
gov/gdp	-0.39	-0.01	0.20		-1.36	-1.21	-1.19
	(0.23)	(0.97)	(0.12)		(0.00)***	(0.00)***	(0.00)***
pop	-0.35	3.80	3.37		-7.46	4.47	4.44
	(0.88)	(0.00)***	(0.01)**		(0.05)*	(0.27)	(0.16)
trade	-0.02	0.03	0.04		0.20	0.18	0.19
	(0.62)	(0.02)**	(0.02)**		(0.00)***	(0.00)***	(0.00)***

Notes: "***", "**", "*" represent 1 percent, 5 percent and 10 percent significance levels, respectively. p-values reported in parentheses.

Table 5. Pre-and-post crisis quantile estimates: South Africa

	Pre-crisis				Post-crisis		
	0.25	0.50	0.75		0.25	0.50	0.75
c	-5.86	-7.17	-12.29		49.75	41.63	23.52
	(0.30)	(0.11)	(0.03)**		(0.00)***	(0.00)***	(0.06)*
inf	-0.37	-0.35	-0.34		-0.53	-0.52	-0.56
	(0.00)***	(0.00)***	(0.00)***		(0.00)***	(0.00)***	(0.00)***
inv/gdp	-0.61	-0.54	-0.30		-0.65	-0.86	-1.48
	(0.00)***	(0.00)***	(0.20)		(0.00)***	(0.00)***	(0.00)***
M3/gdp	0.02	0.03	-0.04		-0.19	-0.10	0.10
	(0.71)	(0.36)	(0.17)		(0.00)***	(0.40)	(0.26)
gov/gdp	-0.38	-0.26	-0.01		-1.53	-1.08	-0.11
	(0.05)*	(0.04)*	(0.95)		(0.00)***	(0.05)*	(0.75)
pop	4.86	5.10	4.50		-7.85	-10.72	-16.84
	(0.00)***	(0.00)***	(0.00)***		(0.00)***	(0.00)***	(0.00)***
trade	0.40	0.34	0.38		0.40	0.42	0.52
	(0.00)***	(0.00)****	(0.00)***		(0.00)***	(0.00)***	(0.00)***

Notes: "***", "**", "*" represent 1 percent, 5 percent and 10 percent significance levels, respectively. p-values reported in parentheses.

6. Conclusion

The inflation-growth relationship is one of the most studied topics within the macroeconomic paradigm and the most recent literature has deliberated for a nonlinear relationship between the two variables. In our study, we investigate this phenomenon for two SSA inflation targeting countries, Ghana and South Africa, using the quantile regression approach which essentially allows us to investigate the influence of inflation on economic growth at different quantile distributions. This aspect of our empirical analysis is of significant policy value since we are enabled to simultaneously and comparatively analyse the effects of low, moderate and high inflation distributions on economic growth for both countries. In particularly, considering that South Africa has a rather low inflation target of 3 to 6 percent whereas for Ghanaian the target is at a moderate rate of 8 percent, our empirical study, by design, is intended to shed much needed light on the suitability of these targets for both inflation targeting countries.

In essence, our empirical results point to nonlinear effects of inflation on growth in both countries although the degree and extent of nonlinearity varies between the two countries. For instance, for Ghanaian data, we observe a negative and significant effect at low inflation rates, an insignificant effect at moderate levels and significantly positive effects at high inflation rates. On the other hand, concerning South African data, we find negative and significant effects at all levels whereby this negative effect is more pronounced at moderate inflation rates and is least pronounced at low levels. The policy implications drawn from the estimates of the full sample point out to Ghanaian central Bank need to further relax their current target, whereas the South African Central Bank should stick to their current low inflation target.

However, in performing our sensitivity analysis which particularly accounts for the global financial crisis of 2007, we discover changing effects in the inflation-growth relationship more specifically for Ghanaian data in which the post-crisis analysis points to a negative relationship across all inflation distributions. However, we note that the least adverse effect of inflation on economic growth for Ghana in the post-crisis are still found to be at high levels. Therefore the policy implications still point to the Ghanaian monetary authorities benefiting from relaxing their 8 percent target to a higher range. On the other hand, we find that the negative inflation-growth relationship across all quantiles still exists for South Africa albeit the least adverse effects being found at moderate levels in the post-crisis period. Ultimately, our empirical results imply that the current inflation-target ranges pursued by both Ghanaian and South African Central Banks are impeding economic growth rates.

In drawing policy implications from our study, we find it advisable for monetary authorities in both countries having to relax their current inflation targets in the interest of improving economic growth rates especially during periods of negative economic conditions as experienced subsequent to global financial crisis. This could possibly involve widening of the lower and upper limits of the targeted inflation bands. Once these economies maintain strong productive and export sectors as well as stronger currencies, then can monetary authorities pursue much stricter inflation targets. Similar intuition can be extended to other African countries, many of which practice some 'less stringent' form of inflation targeting. Notwithstanding the important implications drawn herewith, one major limitation associated with our study concerns our econometric model, which does not permit us to pinpoint an exact optimal inflation level that is growth maximizing. Nevertheless, we reserve such empirical endeavours for future academic aspirations.

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