Ghanaian Journal of Economics, Vol. 7, December 2019

Examining the Threshold Effects of Inflation on Economic Growth in Ghana

Yakubu Awudu Sare[a], Muazu Ibrahim[a*] and Alhassan Musah[b]

[a] Department of Banking and Finance, School of Business and Law, University for Development Studies, Wa, Ghana
[b] Department of Accounting, School of Business and Law, University for Development Studies, Wa, Ghana
[*]Corresponding author: imuazu@uds.edu.gh

Abstract

Promoting sustainable economic growth and maintaining relative price stability comprise the two core macroeconomic policy objectives pursued by Central Banks in several economies, including Ghana. Hitherto, majority of the empirical studies on inflation-growth nexus argues that the impact of inflation on economic growth is non-linear with the precise impact of inflation conditioned on the threshold level. However, earlier literature on the threshold effects of inflation on economic growth relied on rudimentary approach by introducing a quadratic term of inflation into the growth equation without showing how the link is moderated by potential refereeing variables. In this study, we depart from this elementary approach in examining the threshold effects of inflation. We find that inflation-growth nexus is mediated by the level of broad money supply. While inflation negatively affects overall growth, our evidence suggests that, inflation significantly inhibits economic growth when the broad money supply exceeds a threshold of 21.57% of GDP. Below this threshold, the impact of inflation is benign. We discuss key implications for policy.

Keywords*: Inflation, Broad money, Economic growth, Ghana.*

JEL Classifications: *O42, C23*

1. Introduction

It is on record that several developing economies, including Ghana, witnessed higher inflationary pressures from early 1970 to 1990s. According to the available data from the World Development Indicators of the World Bank, Ghana's inflation rate which stood at 3.03% in 1970 consistently increased to 116.45% in 1977 before decreasing to 50.07% in 1980. Indeed, the improvement in inflation rate was only temporal as the rate increased to 116.5% in 1981 and by 1983, it skyrocketed to its all-time highest of 122.88% in 1983. GDP growth rates were also very low around this period and in some cases, the country recorded negative growth rates. For instance, growth rates decreased from 9.72% in 1970 to -12.43% in 1975. Inflation has recently been low in 2000s relative to 1980s and 1990s. At the same time, growth rates have improved. Inflation reduced from 25.19% to 8.73% in 2000 to 2011 which also coincided with higher growth rates of 3.70% to 14.05% in the same period[1]. Adu and Marbuah (2011) have argued that, Ghana's inflation is accounted for by myriad of structural and monetary factors notably real output, nominal exchange rate, broad money supply, nominal interest rate and fiscal deficit. The Central Bank of Ghana adopted the inflation targeting approach in 2002 which is based on a fiscal framework of the government involving a public announcement of a specific rate of inflation jointly determined by the Central Bank and the Ministry of Finance and Economic Planning. Quartey and Afful-Mensah (2014) note that while the inflation targeting framework was ineffective in its early days of implementation, it gained prominence in taming inflation in the year 2010 and beyond.

Undoubtedly, like many countries, one of the most essential goals of macroeconomic policies is to achieve high economic growth together with low inflation. However, there has been substantial debate on the relationship between inflation and growth. Theoretically, Milton Friedman's monetarism emphasised on two key long run properties of the economy that provides the foundation for this study: the quantity theory of money and the neutrality of money. With the former, it links inflation and growth by equating total amount of money in circulation with the overall spending in the economy. According to the monetarists, in the long-run, prices are mainly influenced by growth rate in money supply with no real impact on economic growth and inflation only results if the relative growth rate of money supply far outstrips that of economic growth. In other words, inflation is a product of a rise in the velocity of money at a rate that is higher than the rate of growth in the economy. With regard to the neutrality of money, Friedman argues that, in an economy where prices of every good and service doubles, agents pay twice as much but because their wages have also doubled, these agents are irresponsive to committing twice of their resources to obtaining the same quantity of goods and

---

1. *We present a trend of inflation and GDP growth rate in the appendix.*

services. And because agents anticipate future inflation, they calibrate this behaviour in their decisions and as such, employment and overall output is unaffected. Thus, if neutrality holds, then the equilibrium values of growth rate of GDP and other real variables will be independent of the long run growth of money supply hence rendering inflation benign. This study, however, seeks to answer a critical research question: is the relationship between inflation and economic growth conditioned on the level of broad money supply and other real variables such as, government expenditure and net exports and inflation itself? Is there a statistically significant threshold level of the mediating variables, above or below which inflation affects growth differently? We aim to provide answers to these important questions using Hansen's (2000) sample splitting and threshold estimation approach.

Theoretically, high inflation hampers growth by obscuring the signalling role of relative price movements as a fundamental guide in economic decision making which in turn distorts efficient allocation of resources (Fischer, 1993). Inflation, defined as the sustained increase in general price levels also heightens uncertainty thus exacerbating the cost of doing business all of which are deleterious to overall economic growth. On the other hand, the structuralists opine that inflation is good for growth. The basic thrust of their argument is a positive relationship between inflation and capital accumulation and since capital accumulation fuels growth, it invariably implies that higher rate of inflation is growth-enhancing (Tobin, 1965; Mundell, 1965). Gregorio (1996) also supports the positive impact of inflation on growth based on the substitutability of money and capital. The author argues that an increase in the rate of inflation increases capital accumulation by shifting portfolio from money to capital thereby stimulating economic growth.

While theoretical literature on inflation and growth have evolved over time, empirical studies on this relationship is inconclusive. More so, studies pertaining to developing economies are scanty and those concentrating on Ghana are almost non-existent. Given the dearth of literature, this study is expected to contribute significantly to the existing literature. First, we test the theoretical proposition of whether money supply and other real variables potentially bifurcates the inflation–growth nexus. Indeed, the majority of the earlier studies on the threshold effects have relied on ad hoc approach by introducing a quadratic term of inflation in the growth equation. However, we depart from the rather ad hoc approaches to rigorously examining the threshold linkages under an asymptotic theory that permits the determination of thresholds within a confidence interval. Second, our approach also allows the determination of the effect of inflation on growth when the level of the mediating variable is below and above the threshold beyond just estimating the statistically significant optimal level of inflation.

Our results suggest that the relationship between inflation and economic growth is conditioned on the level of broad money supply in circulation but not the values of government expenditure, net exports and inflation. While inflation negatively affects growth, this effect is less (more) sensitive below (above) broad money supply threshold of 21.57% of GDP.

The rest of the paper is organised as follows: we conduct a brief review of the empirical literature in section 2. In section 3, we outline our data and empirical strategy while section 4 discusses our findings. Section 5 concludes the study with some key implications for policy.

2. Brief Empirical Literature

Kormendi and Meguire (1985) is one of the early empirical writers on inflation-economic growth nexus. The authors' study was a giant step in the literature as their findings largely challenged the conventional positive effect (see Tobin, 1965) in favour of the negative effect. Studies after Kormendi and Meguire (1985) have also found some negative relationship between economic growth and inflation suggesting that higher inflation is not conducive for growth (Fischer, 1993; De Gregorio, 1993; Barro, 1995, 1996). Barro (1995) explored the inflation–economic growth relationship using a large sample covering more than 100 countries from 1960 to 1990. His empirical findings indicate that, when key demographic traits of countries such as fertility and education as held constant, inflation negatively and significantly affects economic growth. More specifically, an increase in the average inflation by 10-percentage points per year reduces economic growth by 0.2 to 0.3 percentage points per year.

Khan and Senhadji (2000) construct separate samples for 140 countries comprising industrial and developing countries in examining non-linearities in inflation-growth nexus and find varying threshold levels. For instance, Khan and Senhadji's (2000) study reveal a threshold level of 1% and 11% for industrial and developing economies respectively. The empirical results strongly suggest the existence of a threshold beyond which inflation hurts growth. Although positive, inflation levels below the threshold levels of inflation have no effect on growth, while inflation rates above the threshold have a significant negative effect on growth. This evidence is in synch with Ghosh and Phillips (1998). Ghosh and Phillips (1998) show that, at lower rates of inflation, inflation and growth are positively correlated, and for higher inflation rates, there exists a negative relationship between inflation and growth. Further findings from the study suggest that the marginal effect of inflation is stronger at lower rates relative to higher inflation rates.

Gillman *et al*., (2002) formalised a non-linear equation within a theoretical model and find a robustly significant negative effect of inflation on economic growth for

OECD countries with a stronger marginal effect stronger at the lower side of inflation rate consistent with Ghosh and Phillips (1998). Notwithstanding these studies, Levine and Zervos (1993) and Sala-i-Martin (1997) suggest that inflation is not a robust determinant of economic growth.

Hasanov's (2010) study also shows the threshold effect of inflation on economic growth in Azerbaijani over the period of 2001-2009. Specifically, the author found a threshold level of 13% beyond which inflation damages GDP growth rates. Sergii (2009) found a similar inverted U-shaped inflation threshold of 8% based on a non-linear least squares technique. Ahmed and Mortaza (2005) empirically examined the relationship between inflation and economic growth in Bangladesh, relying on annual data set on real GDP and consumer price index (CPI) for the period of 1980 to 2005. Results from their co-integration and error correction models suggest a statistically significant long run negative relationship between inflation and economic growth.

Danladi (2013) explores the existence of threshold effect between inflation and economic growth in the context of four West African economies (Burkina Faso, Ghana, Nigeria and Senegal) for the period 1980–2009. Findings from their empirical results strongly suggest the existence of a threshold level of 9% beyond which inflation exerts a negative effect on growth.

In the case of Tanzania, Kasidi and Mwakanemela (2013) examined the impact of inflation on economic growth relying on annual data spanning 1990–2011. While no long run relationship was found between inflation and growth, results from the study suggest that inflation negatively and significantly impacts on economic growth. In Nigeria, Chimobi (2010) examined long run relationship between inflation and economic growth using the Johansen-Juselius co-integration technique. Results from the cointegration test show no long run relationship. Further findings from the Granger causality test reveal a unidirectional causality running from inflation to economic growth. However, this finding sharply contrasts Gokal and Hanif (2004) who find that, the causality between the two variables run one-way from economic growth proxied by GDP growth rate to inflation in Fiji. By employing the vector autoregressive (VAR) approach, Nell (2000) finds that, while inflation within the single-digit zone potentially enhances economic growth, a double-digit inflation largely inhibit growth. These findings are however inconsistent with Mallik and Chowdhury (2001) who found a positive relationship between inflation and growth in all the four countries (Bangladesh, Pakistan, India and Sri Lanka) studied. Interesting, by further interrogating the findings, the authors found that the sensitivity of growth to changes in inflation is smaller relative to the inflation to changes in growth rates. Mallik and Chowdhury (2001) therefore conclude that, although moderate inflation spurs economic growth, higher economic growth absorbs into inflation through overheating.

Indeed, the existing literature on inflation-growth nexus is mixed and inconclusive necessitating further research efforts. While the majority of the extant literature rely on cross-country and panel data which ignores country-specific effects hence may not unearth the precise threshold and nature of the relationship. Thus, recommendations based on findings from these studies cannot be useful for all countries given their neglect to individual countries' unique characteristics. This gap, therefore, calls for country-specific studies. However, in the case of Ghana, studies on inflation-growth relationship are scanty. For instance, using data for the period 1960–2008, Frimpong and Oteng-Abayie (2010) established a threshold effect of inflation on economic growth in Ghana. Results from their Ordinary Least Squares (OLS) and Two-Stage Least Squares (2SLS) reveal a threshold level of 11%. Further interrogation of their results suggest that the impact of inflation on growth is significant even at relatively lower levels of threshold.

Ahortor *et al*., (2010) determine the optimal range within which inflation would have a significant positive impact on GDP growth in Ghana and Nigeria. The optimal inflation range was found to be between 6% and 12% for Ghana and, 9% and 14% for Nigeria suggesting that inflation rate within this range may not hurt economic growth.

Relying on the Johansen co-integration approach, Quartey (2010) finds a negative effect of inflation on growth. Specifically, the author found a growth maximizing inflation rate at 22.2%. Quartey (2010) therefore concludes that achieving optimum growth does not rest on the attainment of single-digit inflation as has been the "gospel" target of the Bank of Ghana. These findings are however inconsistent with Frimpong and Oteng-Abayie (2010).

On his part, Marbuah (2010) investigated the relationship between inflation and economic growth to examine threshold effects in Ghana relying on data spanning 1955-2009. With no structural break, results from the estimation reveals minimum and maximum inflation threshold levels of 6% and 10% respectively. The results also confirm the negative relationship between inflation and growth which is statistically significant even at lower thresholds of 5%. Interestingly, the author observed that, threshold inflation levels below 6% and above 10% do not significantly impact on growth even though it enters with a negative sign.

From the foregoing, the empirical literature is divided along the direction of effect and threshold levels. However, the majority of the threshold studies have relied on elementary approaches by including a quadratic term of inflation in the growth equation. More importantly, these studies have failed to engage the literature in light of the mediating factors influencing the impact of inflation on economic growth. We fill this critical gap in the literature by employing a sample splitting method.

3. Methodology

3.1. Data and preliminary findings

This study relies on annual time series data spanning 1965–2013 gleaned from the World Development Indicators of the World Bank. Consistent with standard literature (Barro, 1995, 1996; Levine *et al*., 2000; Ibrahim and Alagidede, 2018a; Adam *et al.*, 2017), we proxy economic growth by GDP growth rate while inflation is measured by consumer price index which reflects annual percentage change in the cost of an average consumption basket of goods and services. Broad money supply which is taken as a percentage of GDP is the sum of all currency outside banks and demand deposits excluding those of the central government and used to proxy financial deepening. Government expenditure is also expressed as a percentage of GDP and measures final government consumption expenditure. It includes all government current expenditure for purchases of goods and services including payment of wages and salaries of employees in the public sector. We compute net exports as the difference between exports and imports to GDP ratio. Table 1 below presents the preliminary findings of the variables.

Table 1: Descriptive statistics (1965 – 2013)

Variables	Mean	Std. Dev	CV	Min	Max	Correlation	Skewness	Kurtosis
GDP growth	3.65	4.67	1.28	–12.43	14.05	–0.15	–1.14	5.03
Inflation	28.95	28.18	0.97	–8.42	122.88	1.00	2.03	6.93
Broad money	22.53	5.98	0.27	11.31	34.11	–0.23	0.05	2.13
Government expenditure	11.84	2.69	0.23	5.86	20.89	–0.40	0.66	4.67
Net exports	–8.25	7.59	–0.92	–25.27	5.51	0.32	–0.24	2.07

Note: *Each variable has 49 observations. CV and std. dev denote coefficient of variation and standard deviation respectively. Values of the correlation represent the correlation between inflation and the respective variable.*

We find that the average growth rate of GDP over the sample period is 3.65% with a maximum growth rate of 14.05% achieved in 2011. Furthermore, the mean inflation rate is 28.95% with –8.42% and 122.88% as the minimum and maximum levels of inflation. Broad money supply over the study period is also averaged 22.53% while the mean government expenditure is 11.84% with a standard deviation of 2.69. We compute the coefficient of variation (CV) as the ratio of the standard deviation to mean in order to compare their relative volatilities. Thus, a higher (lower) CV represents higher (lower) relative volatility. Our evidence suggests that, among all the variables, GDP growth rate is the most volatile given the value of the CV. We examine the correlation between inflation and all the other four variables and find

that, apart from net exports, inflation is negatively correlated with economic growth, broad money supply and government expenditure albeit weakly given the values of the correlation coefficients. With regard to skewness, we notice that all the variables are positively skewed except GDP growth rate and government expenditure which are negatively skewed. Given the values of the kurtosis and skewness, we conclude that none of the variables follows the normal distribution as they exhibit leptokurtic traits.

Given the aim of finding the threshold effect of inflation on growth potentially mediated by broad money, government expenditure, net exports and inflation using Hansen (2000) sample splitting approach, we specify our empirical strategy in the next section.

3.2. Empirical strategy

The conventional approach to estimating the impact of inflation on economic growth involves specifying equation (1) which loosely regresses economic growth (ECO_t) on inflation (INF_t) in addition to some standard controls (CON_t):

$$ECO_t = \alpha_o + \alpha_1 INF_t + \alpha_2 CON_t + \varepsilon_t \quad (1)$$

where ε_t is the error term.

We can include the square term of INF_t in the baseline equation (1) to examine the nonlinearities in inflation–growth nexus as done in several studies including Quarter (2010). However, this approach is *ad hoc* and involves the imposition of an exogenous threshold. Apart from this, it does not consider the case that such nonlinear relationship between inflation and economic growth may be mediated by some important variables such as broad money supply, government expenditure, net exports and inflation.

The study, therefore, relies on Hansen's (2000) sample splitting approach in an attempt to depart from the weaknesses of earlier studies. Our chosen approach has been used in recent literature to examine fiscal deficit-economic growth nexus in Ghana (Alagidede *et al*., 2018) and financial development-economic growth link in sub-Saharan Africa (Ibrahim and Alagidede, 2018b). With this approach, we are able to make use of the asymptotic theory in estimating the threshold. The Hansen (1996, 2000) estimates the regression parameters by leveraging on the least square estimation which is better than the traditional approaches in that the precise nature of the threshold of this approach is not predetermined in addition to empirically determining the statistical significance of all thresholds identified. We therefore alter equation (1) such that the possibility of inflation influencing growth is refereed by these variables. Our threshold variable k_i is taken as a continuous distribution and the parameters estimated in equation (1) are allowed to vary conditional on the value of k_i. Following this intuition, we estimate two regime threshold models in a single equation below:

$$ECO_i = (\alpha_{11} + \alpha_{21}INF_i + \alpha_{31}THR_i + \alpha_{41}CON_i)d_i\{k_i \leq q\} + (\alpha_{12} + \alpha_{22}INF_i + \alpha_{32}THR_i + \alpha_{42}CON_i)d_i\{k_i > q\} + \varepsilon_i \quad (2)$$

where *THR* is the vector of threshold variables; $d(\cdot)$ is the indicator function of dummy variable that takes the value 1 if the condition is satisfied and 0 otherwise; *k* is the threshold variable while *q* is the threshold value with subscript *i* as country index. The other variables are as previously defined.

We can compactly write equation (2) as equation (3) below given k_i = {broad money supply, government expenditure, net exports and inflation}:

$$ECO_i = \alpha^{\downarrow} z_i + \lambda_n^{\downarrow} z_i(q) + \varepsilon_i \quad (3)$$

where ECO_i is real-valued and z_i is an *m*-vector; $\lambda_n = \alpha_{i2} - \alpha_{i1}$ while $\alpha = \alpha_{i2}$. Notice that as $\lambda_n \rightarrow 0$ as $n \rightarrow \infty$ while α_{i2} is fixed thereby pushing $\alpha_{i1} \rightarrow \alpha_{i2}$ as $n \rightarrow \infty$.

We confine the threshold value *q* to a bounded set $[\underline{q}, \overline{q}] = \pi$ while estimating the least squares using the concentration approach where $\hat{q}$ is the value that minimises the sum of square error $[SSE_n(q)]$. We test the statistical significance of *q* that H_0: $q = q^0$ using the likelihood ratio (LR) test:[2]

$$LR_n(q) = n\frac{SSE_n(q) - SSE_n(\hat{q})}{SSE_n(\hat{q})}$$

When the values of $LR_n(q_0)$ are large, then q is statistically different from zero. We check the reliability of *q* by constructing an asymptotic confidence interval (*c*) within which q falls as $\hat{\pi} = \{q: LR_n(q) \leq c\}$.

4. Results and Discussions

This section discusses the results from the study where we begin by first examining the stationarity properties of our variables by employing the augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979; 1981) and Phillips and Perron (1998) (PP) tests. While the ADF test is built on the assumption that the error terms have constant variance, we avoid this restrictive assumption by complementing the ADF test with the PP test which has relatively less restrictive assumption about the homoskedastic property of the error term apart from its ability to correct for potential serial correction and varying error terms. We first examine the stationarity property of inflation, economic growth, government expenditure, net exports and broad money at (i) constant only and (ii) constant and time trend. We also determine the unit root property on both the levels and first differences where the appropriate lag length is selected in line with the Akaike Information Criterion (AIC). Table 2 below presents results on the unit root tests.

---

2. *Where q_0 is the true value of q.*

Table 2: Unit root tests

Variable	Augmented Dickey–Fuller (ADF) tests		Variable	Phillips–Perron (PP) tests	
	Test statistic	*p*–value		Test statistic	*p*–value
		Panel A Constant and no time trend			
LINFL	-2.444	0.1355	LINFL	-4.328	0.001***
ΔLINFL	-12.113	0.000***	ΔLINFL	-14.405	0.000***
LECO	-4.442	0.001***	LECO	-4.441	0.001***
ΔLECO	-5.525	0.000***	ΔLECO	-29.455	0.000***
LGEXP	-2.434	0.000***	LGEXP	-5.091	0.030**
ΔLGEXP	-6.019	0.000***	ΔLGEXP	-9.131	0.000***
NEXP	-5.249	0.000***	NEXP	-8.239	0.041**
ΔNEXP	-11.633	0.000***	ΔNEXP	-10.312	0.000***
BMON	-9.451	0.000***	BMON	-7.345	0.000***
ΔBMON	-2.391	0.001***	ΔBMON	-9.111	0.000***
		Panel B Constant and time trend			
LINFL	-4.327	0.006***	LINFL	-4.394	0.005***
ΔLINFL	-12.012	0.000***	ΔLINFL	-16.311	0.000***
LECO	-5.437	0.000***	LECO	-5.378	0.000***
ΔLECO	-5.685	0.000***	ΔLECO	-29.141	0.000***
LGEXP	-4.987	0.001***	LGEXP	-11.383	0.000***
ΔLGEXP	-6.731	0.000***	ΔLGEXP	-7.354	0.000***
NEXP	-2.951	0.000***	NEXP	-5.111	0.000***
ΔNEXP	-4.124	0.001***	ΔNEXP	-7.322	0.000***
BMON	-6.011	0.000***	BMON	-9.546	0.000***
ΔBMON	-4.413	0.000***	ΔBMON	-13.765	0.000***

Note: *** and **** respectively denotes significance at 5% and 1% level. Δ denotes first difference and all variables are in natural log (L).respective variable.*

In panel A, the ADF tests show that inflation is non-stationary at levels suggesting that, monetary shocks have a permanent deviation from its mean which may continue to be so over a longer time. However, upon first differencing, it attained stationarity implying that inflation is integrated of order one ($I(1)$). However, economic growth, government expenditure, net exports and broad money are stationary even at levels. Interestingly, results from the PP tests reveal that all the variables are stationary whether we estimate them at levels or first difference. In panel B where the stationarity properties are estimated with constant and deterministic trend, we find that, relative to panel A, inflation is stationary at levels and so are the other variables. We conclude based on our sample evidence that, inflation, economic growth, government expenditure, net exports and broad money are all stationary and integrated of order zero ($I(0)$) at 1% significance level. Thus, shocks to these variables are transitory

and the series tend to revert to their means over time. Given the aim of this study and beyond the stationary property, we test for the existence of thresholds and their statistical significance. Table 3 presents the results on the threshold test.

Table 3: Test of null of no threshold against alternative of threshold

Moderated by	Number of Bootstrap Replications	Trimming Percentage	Threshold Estimate	LM-test for no threshold	Bootstrap p-value
Broad money supply	2000	0.15	21.22	13.78	0.017
Gov't expenditure	2000	0.15	10.63	9.08	0.343
Net exports	2000	0.15	–9.61	8.29	0.478
Inflation	2000	0.15	32.90	9.92	0.240

Note: *All estimations allow heteroskedastic white corrected errors. Gov't = Government*

We test whether inflation-growth nexus is moderated by the level of broad money supply, government expenditure, net exports and/or the level of inflation. The statistical significance of our threshold moderating variables are examined relying on the *p*-values which are computed using the bootstrap approach with 2000 replications and 15% trimming percentage. Results of the threshold tests are presented in Table 3 above under the null hypothesis of no threshold. As shown in the Table, the bootstrap *p*-value of broad money reveals that the test of no threshold effect can be flatly rejected at conventional levels given the rather lower *p*-value. Thus, the sample can be split into two regimes in examining how inflation affects economic growth moderated by the level of broad money supply. This finding may support the traditional economic view that inflation is a monetary phenomenon in that, inflation does not occur without a sustained increase in the amount of money supply in the system. Our evidence may imply that achieving long run price stability can partly be conditioned on the growth of money supply as espoused by the monetarists.

We, however, do not find any threshold effect when the inflation-growth nexus is moderated by government expenditure, net exports and inflation, given the high levels of bootstrap *p*-values. Apart from broad money supply where the trend crosses the 95% critical value (see Fig. 1), all the other mediation variables have their trends below 95% critical values (Fig. 2 to 4). We thus cannot split the sample when inflation effect on growth is mediated by these variables suggesting that, only the single threshold in equation (2) is adequate for the models.

Figure 1: Broad money

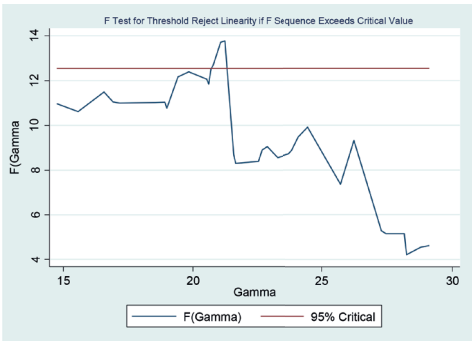


Figure 2: Government expenditure

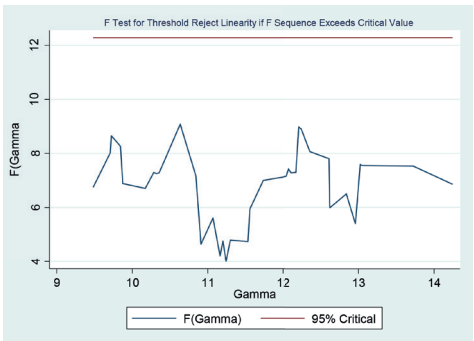


Figure 3: Net exports

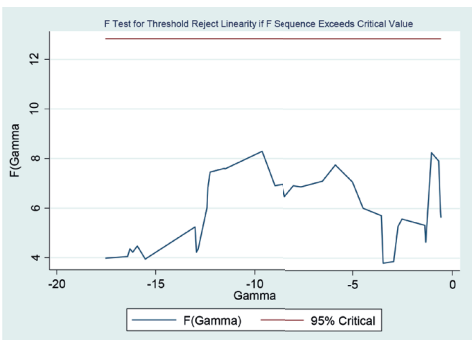
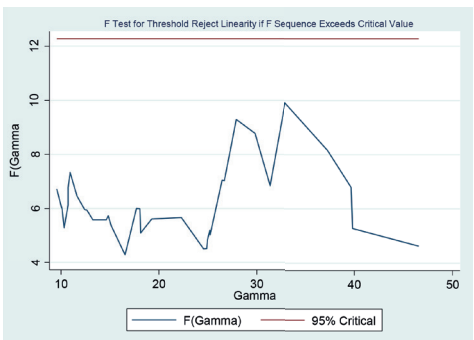


Figure 4: Inflation



Given this understanding, we split the sample based on growth on broad money supply in examining the threshold effects of inflation on economic growth. Findings from these estimations are presented in Table 4.

Table 4 below presents results on our estimations. Columns 1 and 2 respectively present results on the linear and threshold models. The linear model is the estimated global ordinary least squares (OLS) where no threshold term is sought for. Here, we find that, the coefficient of inflation is negative and statistically significant suggesting that higher inflation is deleterious to overall growth. Specifically, a percentage-point rise in inflation reduces growth by 0.016%. Thus, inflation is intrinsically bad news as it potentially discourages investment stemming from higher uncertainty and cost of doing business, erodes domestic savings, motivates intense capital flight and inhibits job creation, all of which muffle long run economic growth.

Table 4: Threshold estimation effects moderated by broad money supply

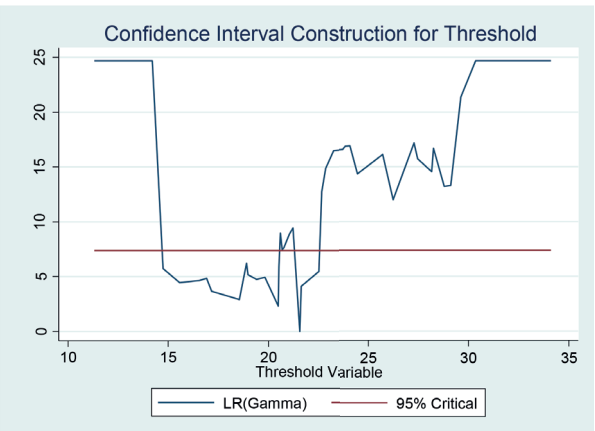
Variables	Linear model	Threshold model	
	Global OLS without threshold	Regime 1 [$q \leq$ threshold]	Regime 2 [$q >$ threshold]
Intercept	1.274	15.025	–0.513
	(3.368)	(4.658)	(3.882)
Inflation	–0.016**	–0.017	–0.012***
	(0.006)	(0.038)	(0.004)
Broad money	0.024	–1.424***	0.133
	(0.113)	(0.448)	(0.111)
Government expenditure	0.036	1.093**	0.085
	1.093**	(0.474)	(0.195)
Net exports	–0.191**	–0.084	–0.110
	(0.092)	(0.179)	(0.090)
Diagnostics (linear model)			
Observations	49		
Sum of squared errors	919.580		
Residual variance	20.900		
R-squared	0.122		
Heteroskedasticity test (*p*–value)	0.331		
Diagnostics (threshold model)			
Threshold estimate		21.567%	
95% confidence interval		[14.746%, 22.513%]	
Observations		24	25
Joint *R*-squared		0.370	
Heteroskedasticity test (*p*–value)		0.330	

Note: *** and **** denote significance at 5% and 1% respectively. Standard errors are in parentheses corrected for heteroskedasticity.*

With regard to the other control variables, both broad money supply and government expenditure positively affects growth albeit insignificantly at conventional levels. Thus, on the linearity framework, the level of money supply and government size do not matter in economic growth. However, the coefficient of net export is negative suggesting that imbalance trade inhibits growth. This effect is statistically significant at 5%. This finding is expected. As the country imports more than it exports, it converts several domestic currencies into foreign currencies to be able to finance the imports thus putting pressure on the local currency which ultimately depreciates. And to the extent that the country exports less, overall long run economic growth suffers.

Given the aim of this study, we introduce a threshold estimation using the sample splitting approach where inflation-growth nexus is mediated by the level of broad money supply. In other words, we determine the threshold level of inflation consistent with long run growth. In doing so, we are also able to evaluate the relative importance of our controls in the growth process given the inflation threshold. Fig. 5 below shows the graph of the normalized $LR(q)$ as a function of the inflation threshold. Notice that the least square estimate of q is the value that minimizes the graph occurs at 21.57% at 95% confidence interval, π = [14.746%, 22.513%] from the graph at which $LR(q)$ crosses the red horizontal line. This finding provides evidence of two-regime specification triggered by broad money supply.

Figure 5: Confidence interval for broad money threshold



In regime 1 where the relationships are examined at q ≤ 21.57%, our findings suggest that, even below this threshold inflation negatively affects growth. However, this effect is statistically insignificant at conventional levels revealing that, while inflation may hurt overall growth, the negative impact of inflation on Ghana's growth is only imaginary when the broad money supply as a percentage of GDP is below 21.57%. Over the sample period of 49 years, we observe a 24-year period where Ghana's average money supply falls below this threshold evidencing that in these periods, inflation was benign to the country's growth rate. Conversely, above this threshold, inflation negatively and significantly damages growth. Interestingly, Quartey (2010) found an inflation threshold of 22% for Ghana. Specifically, the relationship between inflation and economic growth is U-shaped suggesting that any inflation rate above his threshold will lead to moderate gains in GDP growth. Our study, however, shows that such relationship is mediated by the level of broad money supply and that whether below or above the broad money threshold, inflation is inimical to growth. Evidently, this effect is only statistically significant when the level of money supply exceeds its threshold. Above the broad money supply threshold of

21.57%, the associated level of inflation is enough to discourage investment, erodes savings and exacerbates macroeconomic instability with their concomitant negative effect on overall growth. To the extent that domestic savings in Ghana is low (Adam *et al.*, 2017) on the back of weak macroeconomic fundamentals, higher inflation may stultify output growth and impede job creation.

Overall, our evidence suggests that, while inflation potentially is not growth-enhancing, the ultimate impact of inflation on growth is conditioned on a broad money supply threshold above which the effect gains significance. Further findings reveal that, over the sample period 1965–2013, Ghana's average yearly money supply exceeds the threshold in majority of the years under consideration. A cursory look at the descriptive statistic reveals that Ghana's mean broad money supply of 22.53% is already above the threshold level suggesting that the country may be operating in regime 2 where inflation negatively and significantly influences economic growth. This finding, therefore, contributes significantly to our understanding regarding the seemingly conflicting result in the literature by proffering that inflation–growth nexus is mediated by the level of money supply where below (above) the threshold of money supply, the effect of inflation is benign (malignant).

With regard to the other variables, we find that relative to the linear model, the coefficient of broad money supply changes both sign and significance. For instance, the coefficient turns negative and slightly significant at 10% when money supply is below 21.57%. Interestingly, this effect reverts to positive but loses its statistical significance when money supply is above the threshold. In regime 1, government expenditure positively and significantly influences growth suggesting that government size is growth-enhancing at lower money supply to GDP ratio. However, at higher money supply proportion, this effect becomes insignificant although positive. Thus, at persistently rising money supply, government expenditure may be ineffective in promoting long run economic growth. Net export-growth nexus is also insignificant when money supply exceeds the threshold although it has a negative coefficient.

5. Conclusion and Policy Implications

This paper examines the threshold effects of inflation on economic growth in Ghana using annual time series data spanning 1965–2013. We employ a sample splitting approach to determine whether the impact of inflation of growth is moderated by broad money supply, government expenditure, net exports and inflation. We find that inflation-growth nexus is only refereed by the level of broad money supply. While inflation negatively affects overall growth, the effect is contingent on the threshold value of money supply. For instance, our evidence suggests that, inflation significantly inhibits economic growth when broad money supply-to-GDP ratio exceeds a threshold of 21.57%. However, below this threshold, the impact of inflation is less harmful.

Given that Ghana's average broad money supply is already above this threshold, policy recommendations would require the Central Bank to institute policies aimed at controlling the level of money supply reasonably below the threshold. This is because higher money supply potentially raises aggregate demand thus spurring inflation which distorts relative price signals and efficient allocation of resources all of which impede economic growth. The present study, therefore, holds important implications for the Bank of Ghana in the conduct of fiscal and monetary policies.

About the Authors

Yakubu Awudu Sare is a Senior Lecturer in the Department of Banking and Finance and the Dean of the School of Business and Law, University for Development Studies, Wa Campus, Ghana. He holds a Bachelor's degree in Business Administration (Accounting Option) from the Islamic University affiliated to University of Ghana, Legon. He also holds MPhil and PhD in Finance from the University of Ghana, Legon. He has presented papers in many international and local conferences as well as published in both international and local peer reviewed journals. With Accounting and Finance background, his research is on capital markets, SMEs financing, development finance with special focus on energy finance, energy consumption and its impact on the environment especially in the developing countries and sub-Saharan Africa in particular.

Muazu Ibrahim holds a PhD in Finance from Wits Business School, University of the Witwatersrand, Johannesburg, South Africa. He also holds an MSc. in Development Economics from the School of Oriental and African Studies (SOAS), University of London, UK and a first class degree in Economics from the Kwame Nkrumah University of Science and Technology (KNUST), Ghana. He teaches in the Department of Banking and Finance, School of Business and Law, University for Development Studies, Wa Campus, Ghana. He is an applied economist with research interests in development finance, financial markets and institutions, risk modelling and macroeconomic shocks. Ibrahim's research is broadly macro, largely motivated by contemporary policy related issues. His research has over the years focused on the dynamic linkages between macroeconomic policies and financial sector development in particular and how they uniquely affect economic growth. He has published extensively in several peer reviewed journals.

Alhassan Musah holds a PhD in Endogenous Development from the University for Development Studies (UDS). He also holds an MSc in Microfinance from University of Bergamo, Italy and a Bachelor of Commerce from the University of Cape Coast, Ghana. He is a fellow of the Association of Certified Chartered Accountants (FCCA), UK and a member of the Institute of Chartered Accountants (ICA), Ghana. He is a Senior Lecturer in the Department of Accounting, School of Business and Law,

UDS, Wa campus where he teaches Accounting, Auditing and Microfinance. His main research interests are in public sector accounting, informal finance, auditing and international development. He has experience managing development programmes, and was previously the Ghana Project Manager for YouthSave, a consortium project studying youth demand for savings in developing countries.

References

Adam, I. O., Musah, A., and Ibrahim, M. (2017). Putting the Cart before the Horse? Re-examining the Relationship between Domestic Savings and Economic Growth in Selected sub-Saharan African Countries. *Journal of African Business*, 18(1), 102–123.

Adu, G., and Marbuah, G. (2013). Determinants of Inflation in Ghana: An Empirical Investigation. *South African Journal of Economics*, 79(3), 251–269.

Ahmed, S., and Mortaza, G. (2005). Inflation and Economic Growth in Bangladesh: 1981-2005. Policy Analysis Unit (PAU) Working Paper 0604.

Ahortor, C. R. K., Adenekan, A., and Ohemeng, W. (2010). An estimate of inflation threshold in the WAMZ: The case of Ghana and Nigeria. *Journal of Monetary Economic Integration*, 11(2), 158–201.

Alagidede, P., Mensah, J. O. and Ibrahim, M. (2018). Optimal Fiscal Deficit Financing in a Constrained Fiscal Space in Ghana. *African Development Review*, 30(3), 291–303.

Barro, R. J. (1996). Determinants of Economic Growth: A Cross-Country Empirical Study, NBER Working Paper, 5698.

Barro, Robert J. (1995). Inflation and Economic Growth, NBER Working Paper 5326.

Chimobi, O. P. (2010). Inflation and Economic Growth in Nigeria. *Journal of Sustainable Development*, 3(2), 159–166.

Danladi, J. D. (2013). Inflation and Sustainable Output Performance in the West African Sub-Region: The Threshold Effect. *American Journal of Economics*, 3(6), 252–259.

De Gregorio, José (1993). Effects of Inflation on Economic Growth: Lessons from Latin America. *European Economic Review*, 36, 417–25.

Dickey, D. A., and Fuller, W. A. (1979). Distribution of Estimates of Autoregressive Time Series with Unit Root. *Journal of the American Statistical Association*, 74, 427–31.

Dickey, D. A., and Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series. *Econometrica*, 49, 1057–1072.

Fischer, S. (1993). The role of Macroeconomic Factors in Growth. *Journal of Monetary Economics*, 32, 485–512.

Frimpong, J. M., and Oteng-Abayie, E. F. (2010). When is Inflation Harmful? Estimating the Threshold Effect for Ghana. *American Journal of Economics and Business Administration*, 2(3), 232–239.

Ghosh, A. and Phillips, S. (1998). Warning: Inflation may be Harmful to your Growth, International Monetary Fund Staff Papers, 45, No. 4: 672–710.

Gillman, M., Harris, M., and Mátyás, L. (2002). Inflation and Growth: Some Theory and Evidence, 10th International Conference on Panel Data, Berlin, July 5-6, 2002 D5-1.

Gokal, V. and Hanif, S. (2004). Relationship between Inflation and Economic Growth, Working Paper, 04, Reserve Bank of Fiji.

Gregorio, J. (1996). Inflation, Growth, and Central Banks: Theory and Evidence, World Bank Policy Research Working Paper 1575, Policy Research Department, Macroeconomics and Growth Division.

Hansen, B. E. (1996). Inference when a Nuisance Parameter is not identified under the Hypothesis. *Econometrica*, 64(2), 413–430.

Hansen, B. E. (2000). Sample Splitting and Threshold Estimation. *Econometrica*, 68(3), 575–603.

Hasanov, F. (2010). Relationship between Inflation and Economic Growth in Azerbaijani Economy: Is there any Threshold Effect? *Asian Journal of Business and Management Sciences*, 1(1), 1–11.

Ibrahim, M., and Alagidede, P. (2018a). Effect of Financial Development on Economic Growth in sub-Saharan Africa. *Journal of Policy Modeling*, 40(6), 1104–1125.

Ibrahim, M., and Alagidede, P. (2018b). Nonlinearities in Financial Development and Economic Growth Nexus: Evidence from sub-Saharan Africa. *Research in International Business and Finance*, 46, 95–104.

Kasidi, F., and Mwakanemela, K. (2013). Impact of Inflation on Economic Growth: A Case Study of Tanzania. *Asian Journal of Empirical Research*, 3(4), 363-380

Khan, M. S., and Senhadji, A. S. (2000). Threshold effects in the relationship between Inflation and Growth, IMF Working Paper, 110, 1–31.

Kormendi, R. C., and Meguire, P. G. (1985). Macroeconomic Determinants of Growth: Cross-Country Evidence. *Journal of Monetary Economics*, 16(2): 141–163.

Levine, R., and Zervos, S. (1993). What We Have Learned About Policy and Growth from Cross-Country Regressions? *American Economic Review Papers and Proceedings*, 83, 426–30.

Levine, R., Loayza, N., Beck, T. (2000). Financial Intermediation and Growth: Causality and Causes. *Journal of Monetary Economics*, 46(1), 31–77.

Mallik, G. and Chowdhury, A. (2001). Inflation and Economic Growth: Evidence from Four South Asian Countries. *Asian Pacific Development Journal*, 8(1), 123–135.

Marbuah, G. (2010). On the Inflation-Growth Nexus: Testing for Optimal Inflation for Ghana. *Journal of Monetary and Economic Integration*, 11(2), 54–82.

Mundell, R. (1965). Growth, Stability and Inflationary Finance. *Journal of Political Economy*, 73, 97–109.

Nell, K. (2000). Is Low Inflation a Precondition for Faster Growth, The Case of South Africa, Department of Economics, University of Kent, United Kingdom.

Phillips, P. C. B., and Perron, P. (1998). Testing for a Unit Root in Time Series Regression. *Biometrika*, 32, 301-318.

Quartey, P. (2010). Price Stability and the Growth Maximizing Rate of Inflation for Ghana. *Modern Economy*, 1, 180–194.

Quartey, P., and Afful-Mensah, G. (2014). Financial and Monetary Policies in Ghana: A Review of Recent Trends. *Review of Development Finance*, 4, 115–125.

Sala-i-Martin, X. (1997). I Just Ran Two Million Regressions. *American Economic Review*, 87(2), 178–83.

Sergii, P. (2009). Inflation and Economic Growth: The Non-Linear relationship: Evidence from CIS Countries, Kyiv School of Economics, Ukraine.

Tobin, J. (1965). Money and Economic Growth. *Econometrica*, 33, 671–684.

Appendix: Trends of inflation and GDP growth rate (%)