International Journal of Economics, Commerce and Management
United Kingdom Vol. IV, Issue 8, August 2016
http://ijecm.co.uk/ ISSN 2348 0386

"INFLATION – OUTPUT GROWTH NEXUS IN NIGERIA" A THRESHOLD ANALYSIS

Kenneth O. Obi
Department of Economics, Nnamdi Azikiwe University, Awka, Nigeria
ko.obi@unizik.edu.ng

Anthony A. Uzodigwe
Department of Economics, Nnamdi Azikiwe University, Awka, Nigeria
uzodigwetony@gmail.com

Abstract

The question of what constitutes the optimal inflation rate has been variously investigated in literature. Our work, though similar to previous studies, differs significantly from our general-to-specific approach. The study examined the inflation-output growth nexus using annual data set spanning from 1970 – 2015. On the assumption that there are no structural changes in Nigeria, we estimated an inflation threshold model for the period 1970 – 2015. Relaxing this assumption, we estimated three inflation threshold models for Nigeria for three periods: 1970 - 1986 (pre-SAP era); 1986 – 1998 (post-SAP era) and 1999 - 2015 (the era of civil rule). The study found different inflation threshold levels for Nigeria across periods – 12%, 11%, 7% and 8% for 1970 – 2015, 1970 – 1985, 1986 – 1998 and 1999 – 2015 respectively. The study also found that the variables of the model share long-run relationship amidst strong evidence of structural changes. Based on our major finding, we conclude that threshold level of inflation in Nigeria differs across regimes and changes as the macroeconomic environment changes. The paper recommends that policy makers should monitor inflation closely and choose an optimal inflation rate, which is consistent with long-term sustainable economic growth.

Keywords: Inflation, Output, Economic Growth, Threshold, Nigeria.

INTRODUCTION

Understanding the nexus between inflation and growth of gross domestic product is very crucial in setting policy targets. This understanding is also necessary considering the fact that rapid output growth and low inflation are the most common objectives of macroeconomics in both developed and developing economies. And the behaviour of these variables dictates the direction and pace of other macroeconomic indicators both in the longer or medium terms. In literature, there is recognition that the relationship between inflation and growth economic depends on the level of inflation prevailing at that time. Substantial theoretical and empirical studies, such as Christoffersen and Doyle (1998), Sarrel (1998) and Khan and Senhadji (2001), queried this issue and arrived at several conclusions. At some low levels, inflation may promote economic growth by making prices and wages more flexible (Lucas, 1973). However, medium and high levels inflation is likely to be inimical to growth. This relationship has been translated into the use of threshold models, which suggest that when inflation exceeds the threshold, it becomes immediately very detrimental to growth, a result that would call for immediate policy changes (Sergii, 2009; Doguwa, 2012).

If high inflation is harmful to the economy and low inflation is beneficial, then the question of what represents the threshold level of inflation for an economy becomes necessary. Empirically, there is no consensus on what the optimal inflation rate is; the rule of thumb is 5% for developed countries and about 10% - 11% for developing countries. This paper is aimed at analyzing the non-linear inflation-growth relationship in Nigeria. We make use of annual time series data over the period 1970 – 2015, assuming the Nigerian economy has not undergone structural changes. Relaxing this unlikely assumption, we decompose our time period into three sub-periods: the Pre-SAP era, 1970 – 1985; the Post-SAP/Pre-Civil rule era, 1986 – 1998; the era of civil rule, 1999 – 2015. We chose the start date 1970 in order to exclude the effect of political instabilities, especially the effect of the civil war on our data set.

Though several empirical studies in Nigeria have investigated the inflation-output growth nexus with specific emphasis on what constitute the optimal level of inflation, the results are mixed and conflicting. For instance, Salami and Kelikume (2010) using annual data for the period 1970 to 2008 and 1980 to 2008 estimated an optimal inflation level for Nigeria. The study detects threshold level of 8% for the period 1970 to 2008 and an insignificant threshold level of 7% is detected for the period 1980 to 2008. Also Bassey and Onwioduokit (2011) using annual data from 1970 to 2006 and the framework developed by Li (2005) established a statistically insignificant threshold level of 18 per cent. Other similarly studies, including Fabayo and Ajilore (2006); Bawa and Abdullahi (2012); Doguwa (2012) and Ajide and Lawanson (2011) estimated different threshold levels of inflation for Nigeria.

Our preoccupation in this study is to analyse the non-linear interaction between inflation and growth using a non-linear Least squares approach, first, we estimate the threshold level of inflation. Second, we examine the impact of inflation threshold on output growth. Our work, though similar to the above studies, differs significantly from our general-to-specific approach. One of the greatest shortcomings of the older studies (especially; Salami & Kelikume 2010; Bassey & Onwioduoki, 2011; Bawa & Abdullahi, 2012) on non-linear and concave inflation-growth relationship is their obvious treatment of the Nigerian economy as if there had not been any structural break. None of these studies attempted to investigate the possibility of structural breaks econometrically, this present study, also fills part of this empirical gap.

The issue of structural break plays a very important role in our analytical approach. To this end, our time frame of study, 1970 – 2015, is further divided into sub-periods: Pre-SAP era (1970 – 1985); the Post-SAP/Pre-Civil rule era (1986 – 1998) and the era of civil rule (1999 – 2015). This categorization is necessary for evaluations and/or comparisons and has serious implication for policy decisions in Nigeria. If inflation is indeed inimical for economic growth when it reaches a particular optimal level, then knowing this level as well as potential losses of output growth in the short run and in the long run is crucial for formulating macroeconomic policies.

The rest of the paper is structured into five sections as follows. Following the introduction in Section one is Section two which reviews the relevant literature on inflation and growth. Section three outlines the theoretical framework and the model specification; Section 4 presents the estimation results. Section 5 concludes.

LITERATURE REVIEW

In theory, several conclusions have been reached on the responsiveness of output growth to inflation. This paper examines various economic theories and empirical studies on the inflation-economic growth nexus.

Abundant theoretical studies have explored the relationship between inflation and output growth. These studies can be classified into two groups. The first group contains inflation among dependent variables. For example, Clarida, Gali and Gertler (1999) and Gali and Gertler (2007) models are given by a system of three blocks of equations, describing aggregate demand, aggregate supply and monetary policy. The models are based on real business cycle theory, extended with monopolistic competition and nominal price rigidities. The main difference between this model and the traditional Keynesian model is that "all coefficients of the dynamic system describing the equilibrium are explicitly derived from the underlying theory". In this framework, inflation influenced real output through real interest rate channel (Fischer equation) in the demand block and affects growth through expectation in prices in the supply block (Sergii).

A different group of growth models does not explicitly include inflation in the framework. This group contains, among other models, the exogenous growth model for a small open economy developed by Minford and Meenagh (2006) and the endogenous growth model with public goods proposed by Barro (1995). These models have their roots in the inter-temporal utility function and perfect competitive firm sector with some production function. These frameworks differ from each other by some minor assumptions, having at the same time the common result. They determine a steady-state growth rate endogenously (Sergii, 2009).

While the first group of models explicitly includes inflation as a factor of economic growth, the second group does not. And since policy makers are particularly concerned with the first group of the models, this study builds on it.

Empirically, numerous studies have explored the inflation-output growth nexus. Like the theoretical models, the existing empirical studies reflect different views on the relationship between inflation and economic growth. The findings differ depending on data periods and countries, suggesting that the association between inflation and output growth is not stable. Still, economists now widely accept the existence of a non-linear and concave relationship between these two variables (Sergii, 2009).

The studies on inflation thresholds have concentrated majorly on two broad areas of research. The first being those who conducted studies on inflation thresholds-growth using cross countries datasets (Fischer, 1993; de Gregorio 1992, 1994; Sarrel, 1996; Phillips, 1998; Bruno and Easterly, 1995; Khan and Senhadji, 2001; Kremer et al, 2009) and those who focused mainly on country specific experiences (such as Nell, 2000; Faria and Carneiro, 2001; Hussain, 2005; Mubarik, 2005; Doguwa, 2012 and the likes).

Fischer (1993) and de Gregorio (1992, 1994) have investigated the link between inflation and growth in time-series, cross section and panel data sets for a large numbers of countries. The main result of these works is that there is a negative impact of inflation on growth. Fischer (1993) argued that inflation hampers the efficient allocation of resources due to harmful changes of relative prices. At the same time relative prices appear to be one of the most important channels in the process of efficient decision-making.

Barro (1997) employed a panel data for 100 countries over the period 1960-1990 to investigate the impact of inflation on economic performance by using Instrumental Variables (IV) technique. He obtained clear evidence that a negative relationship exists only when high inflation data was included in the sample. But there is not enough information to argue that the same conclusion holds for lower inflation rate. Barro has estimated that 10% of inflation reduces real GDP per capita by 0.2% per year. Despite the fact that adverse impact of inflation is quite small in percentage expression, the long-term effects on standards of living in nominal values may be considerable.

Malla (1997) used a small sample of eleven OECD countries in a pooled time series and cross-section fashion to examine the relationship between inflation and growth. He concluded that the negative effects of inflation on economic growth more than outweigh its positive effects.

Some other studies have shown that the link between inflation and growth is significant only for certain levels of inflation. For instance, Bruno and Easterly (1995) examined the possible relationship between inflation and growth for 26 countries over the 1961- 1992 period. The study shows that inflation has negative impact on growth when level of inflation exceeds some threshold. At the same time they showed that impact of low and moderate inflation on growth is quite ambiguous. They argued that in this case inflation and growth are influenced jointly by different demand and supply shocks thus no stable pattern exists.

In recent time, the emphasis has been on non-linear and concave relationship between inflation and economic growth. Fischer (1993) was the first who investigated this non-linear relationship. He used cross-sectional data covering 93 countries. The author used the growth accounting framework in order to detect the channels through inflation impacts on growth. As a result, he found that inflation influences growth by decreasing productivity growth and investment. Moreover, the author showed that the effect of inflation is non-linear with breaks at 15 and 40 percent. Further, examining the non-linear relationship between inflation and economic growth, Burdekin (2000) showed that the effects of inflation on growth reverses substantially as the inflation rate rises. He concluded that the threshold at which inflation first begins to negatively affect growth is around 8 per cent for industrial economies and 3 per cent or less for developing countries.

Khan and Senhadji (2001) investigated the inflation-growth interaction for both developing and developed countries applying the technique of conditional least squares. They used the panel data set on 140 countries (both industrial and developing) over the period 1960-1998. The authors employed the method of non-linear least squares to deal with non-linearity and non-differentiability of the inflation threshold level in growth regression. As a result, they obtained estimates of the threshold levels of 1-3% for developed and 11-12% for developing countries, which turned out to be very precise. The authors mentioned that the total negative effect of inflation may be underestimated due to the fact that they controlled investment and employment, so the main channel of impact is productivity. Nevertheless, this study asserted the idea that low inflation is a good thing for the economy because it has favorable influence on growth performance.

Drukker, Gomis-Porqueras & Hermandez-Verme (2005) used data from a sample of 138 countries from 1950 to 2000 to investigate the threshold effects in the relationship between inflation and economic growth. The panel regression results revealed that there is one threshold with an estimated value of 19.16 per cent that is well identified by the full sample. For the industrialized sample, the results indicated that there are two threshold points at 2.57 per cent and 12.61 per cent.

In Nigeria, numerous empirical studies have also investigated the non-linear and concave relationship between inflation and growth. Fabayo and Ajilore (2006), for instance examined the existence of threshold effects in inflation-growth relationship using Nigeria data for the period 1970-2003. The results suggest the existence of inflation threshold level of 6%. Below this level, there exists significantly positive relationship between inflation and economic growth, while above this threshold level, inflation retards growth performance. Sensitivity analyses conducted confirmed the robustness of these results. This finding suggests that bringing inflation down to single digits should be the goal of macroeconomic management in Nigeria.

To corroborate the earlier findings by Fabayo and Ajilore (2006), Salami and Kelikume (2010) investigated the inflation thresholds for Nigeria using annual time series data spread over two periods 1970-2008 and 1980-2008. Using a non linear inflation-growth model, control variables such as growth in the ratio of broad money supply to GDP (GLM2/GDP) and growth in term of trade (GLTOT), they established an inflation threshold of 8 percent for Nigeria over the sample period 1970-2008.

Similarly, Doguwa (2012) using three different approaches that provide appropriate procedures for estimating the threshold level and inference re-examined the issue of the existence and the level of inflation threshold in the relationship between inflation and growth in Nigeria. While Sarel's (1996) approach provides a threshold point estimate of 9.9 per cent that was not well identified by the data, the technique of Khan and Senhadji (2001) identifies a 10.5 per cent inflation threshold as statistically significant to explain the inflation-growth nexus in Nigeria. Also, the approach of Drukker et al (2005) suggests a two threshold point model with 11.2 and 12.0 per cent as the appropriate inflation threshold points. These results suggest that the threshold level of inflation above which inflation is inimical to growth is estimated at 10.5 to 12 per cent for Nigeria. Using the estimated two threshold point model, this paper did not find enough reasons to accept the null hypothesis of the super-neutrality of money, and therefore, suggest that there is a threshold level of inflation above which money is not super-neutral.

METHODOLOGY

Theoretical Framework

Numerous empirical studies based on endogenous, neoclassical and neo-Keynesian growth theories have this common problem of producing an exact list of explanatory variables (Sergii, (2009). For instance, while all theories agree that the level of technology is an important determinant of growth, there is no single way to measure this variable. Sala-i-Martin (1997) mentioned such potential candidates on the role of "level of technology" as market distortions, distortionary taxes, maintenance of property rights and degree of monopoly. The same is true for such growth determinants as "human capital" or "efficient government".

However, the neoclassical growth model developed by Cass (1965) and Koopmans (1965) insists on including such variables as investment and population growth in the growth regression. This model predicts that an increase in investment together with a decrease in population growth rate promotes economic growth. In addition, international trade theory proposes to include openness of the economy in the growth regression. For example, a model of monopolistic competition with heterogeneous firms developed by Melitz et al. (2003) predicts that greater trade openness of the economy leads to the higher economic growth. In particular, the country can stimulate exports due to higher efficiency of domestic firms-exporters, which leads to higher growth. At the same time, if the country removes trade barriers then more foreign firms will import stimulating competition on the domestic market. Hence, less productive domestic firms will have to leave the market, because only the most productive firms will be exporters. As a result growth will be promoted.

The Model

In analysing inflation-growth nexus, we begin with the following growth regression model, which appeared as a basic step in the empirical studies of Barro (1991) and Sala-i-Martin (1997):

$$d \log GDPG = X\beta + \varepsilon \qquad (1)$$

Where GDP is real output growth, X is the matrix of explanatory variables, β is the matrix of coefficients and ε is the error term.

Modifying the above model in line with the above theoretical framework and following empirical growth literature, especially the works of Sergii (2009); Levin and Renelt (1992) and Sala-i-Martin (1997), we obtain following simplified growth function:

$$GDPG_t = \beta_0 + \beta_1 POPGR_t + \beta_2 INF_t + \beta_3 OPNS_t + \varepsilon_t \qquad (2)$$

Where: POPGR is the population growth; INF is inflation rate and OPNS is the openness of the economy.

The choice of these variables is in tandem with the choice made by other researchers such as Khan and Senhadji (2001); Drukker et al (2005) and Sergii (2009).

The Threshold Regression Model

Having specified our growth model based on macroeconomic theoretical framework and empirical growth literature, albeit with some modification, we develop the threshold regression model to assess the optimal inflation rate for Nigeria above which inflation may become inimical to economic growth in Nigeria. This study adopts the threshold regression model developed by Khan and Senhadji (2001) to analyse the threshold level of inflation for both industrial and developing countries. The model has been applied by several researchers such as Mubarik (2005) and Hussain (2005) in computing the threshold inflation rate for Pakistan; Frimpong and Oteng- Abayie (2010) for Ghana; Bawa & Abdullahi (2012) and Doguwa (2012) for Nigeria.

The general form of our growth regression with threshold takes the following form:

$$GDPG_t = \Pi_0 + \Pi_1 INF_t + \Pi_2 DUM_t{*}(INF_t\text{-}K) + \Pi_{2+i} X_{it} + U_t \qquad (3)$$

Where, K is the threshold level of inflation.

The dummy variable Dum_t is defined in the following way:

$DUM_{t} =$ 1, if INF > K, or 0, if INF ≤ K.

The variable X_{it} is a vector of control variables which include: the population growth (POPGR) and the openness of the economy (OPNS). These variables are added to the model to serve as control variables in the analysis.

According to Mubarik (2005) the parameter K (that is the threshold inflation level) has a property that the relationship between economic growth and inflation is given by: (i) Π_1 indicates low inflation; (ii) ($\Pi_1 + \Pi_2$) represents high inflation. The high inflation means that when the long-run inflation estimate is significant then both coefficients would be added to see their impact on growth and that would be the threshold level of inflation. By estimating regressions for different values of k which is chosen in an ascending order (that is 1, 2, 3 so on), the optimal value of k is obtained by finding the value that maximizes the R^2 from the respective regressions. In other words, the optimal threshold level (k*) is that which minimizes the Residual Sum of Squares (RSS). The lack of knowledge of the optimal number of threshold points and their values complicates estimation and inference. Though the procedure is widely accepted in the empirical literature, it is tedious since several regressions have to be estimated. Khan and Senhadji (2001) discuss the details of the estimation procedure and the computation methods.

To estimate the threshold level of inflation, the study employed the conditional least square technique. The idea is to minimize the sum of squared residuals (RSS) or maximize the coefficient of determination (R^2) in the growth regression, conditional on a particular threshold level. We repeat the procedure for different threshold values from 5% to 20%.

Estimation Procedure and Techniques

Before the estimations and inferences, the time series properties of the variables are investigated in order to ascertain the order of integration. The Augmented Dickey Fuller (ADF) unit root test is utilized. ADF test is based on the null hypothesis that a unit root exists in the time series. There are many ways of testing for unit root, but the Augmented Dickey Fuller (ADF) test is adopted, because it is reliable and robust and eliminates the presence of autocorrelation in the model. In the event that all the variables are integrated of the same order, the Autoregressive Distributed Lag (ARDL) approach (which utilizes the bounds testing approach to cointegration) proposed by Pesaran and Shin (1999) and Pesaran et al. (2001) is used to assess the existence of long-run relationship among the variables. The ARDL model is derived from equation (1) as follows:

$$\Delta GDPG_t = \theta_0 + \sum_{p=1}^{n} \theta_1 \Delta GDPG_{t-1} + \sum_{p=1}^{n} \theta_2 \Delta POPGR_{t-1} + \sum_{p=1}^{n} \theta_3 \Delta INF_{t-1} + \sum_{p=1}^{n} \theta_4 \Delta OPNS_{t-1} + \Phi_1 GDPG_{t-1} + \Phi_2 POPGR_{t-1} + \Phi_3 INF_{t-1} + \Phi_4 OPNS_{t-1} + \varepsilon \quad (5)$$

Upon the rejection of the null hypothesis of no cointegration, a short run error correction model of the form is estimated:

$$\Delta GDP_t = \theta_0 + \sum_{p=1}^{n} \theta_1 \Delta GDP_{t-1} + \sum_{p=1}^{n} \theta_2 \Delta POPGR_{t-1} + \sum_{p=1}^{n} \theta_3 \Delta INF_{t-1} + \sum_{p=1}^{n} \theta_4 \Delta OPNS_{t-1} + \theta_5 VECt + \varepsilon_t \quad (6)$$

And *v* is the coefficient of the error term which measures how the short run disequilibrium in the model adjusts within a period.

Data Sources and Measurement of Data

The model was estimated using annual time series data spanning from 1970 to 2015 for Nigeria, divided into sub-periods. The data set was sourced from the CBN Annual Report and Statement of Accounts, CBN Statistical Bulletin and the National Bureau of Statistics Annual Abstract of Statistics World Economic Outlook (WEO).

Growth of real GDP is measured as annual percentage growth rate of GDP at market prices based on constant (1990 base year) Nigeria's currency in Billions; inflation is computed as annual percent change of average consumer price index. Data for inflation are averages for the year, not end-of-period data (The index is based on 2000=100); growth rate of population is measured as annual population growth rate. Population measure is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. Openness of the economy is measured as share of export plus import in GDP.

ANALYSIS AND FINDINGS

Descriptive Statistics

First, we present the summary statistics of the all the variables used in the analysis. We do this for the common sample periods and for the sub-periods.the results are shown in the following tables:

Table 1: Descriptive statistics for the period 1970 – 2015 (the full sample)

	GDPG	INF	OPNS	POPGR	LINF
Mean	3.83	18.37	47.89	2.61	2.64
Max.	25	72.80	81.81	3.05	4.28
Min.	-13.13	3.2	19.60	2.29	1.16
Std Dev.	6.57	15.54	16.15	0.16	0.71
Obs.	46	46	46	46	46

Table 1 describes our main data sample spanning from 1970 – 2015. The average value of growth rate of output is 3.83%. Inflation has mean 18.37%, which is higher than Sani (2012) estimated threshold levels of 9.9%, 10.5%, 11.2% and 12.0%. Openness of the economy has average value 47.89%, this indicates that the Nigerian economy is export and import oriented. The average growth rate of population for the period is 2.61, suggesting that the population is still increasing in Nigeria. Logarithm of inflation has average value 2.64%. It is instructive to note that transformation made distribution of logarithm of inflation much narrow than inflation – mean (2.64% and 18.37%), minimum value (1.16% and 3.2%) and maximum value (4.28% and 72.8%).

Table 2: Descriptive statistics for the period 1970 – 1985 (Pre-SAP era)

	GDPG	INF	OPNS	POPGR	LINF
Mean	3.83	16.09	35.43	2.66	2.58
Max.	25	39.60	48.57	3.05	3.67
Min.	-13.13	3.20	19.60	2.29	1.16
Std Dev.	9.21	10.01	19.60	0.25	0.68
Obs.	16	16	16	16	16

In table 2, we present the summary statistics of our data for the sub-periods, 1970 – 1985 (Pre-SAP era). The average value of growth rate of output for this period is 3.83%, which is the same for the full sample data. Inflation has mean value of 16.09%, which is less than the full sample, and still higher than Sani (2012) estimated threshold levels of 9.9%, 10.5%, 11.2% and 12.0%. Openness of the economy has average value35.43%, this result suggests a decline in export-import activities when compared with the evidence from the full sample. The average growth rate of population for the period is 2.66, suggesting that the population is still increasing in Nigeria. Logarithm of inflation has average value 2.58%. Again the transformation made distribution of logarithm of inflation much narrow than inflation; with mean (2.58% and 16.09%), minimum value (1.16% and 3.2%) and maximum value (3.67% and 39.60%).

Table 3: Descriptive statistics for the period 1986 – 1998

	GDPG	INF	OPNS	POPGR	LINF
Mean	1.57	30.35	53.92	2.55	3.07
Max.	12.77	72.80	76.86	2.64	4.29
Min.	-10.75	5.40	23.75	2.50	1.69
Std Dev.	6.25	23.01	14.42	0.05	0.91
Obs.	13	13	13	13	13

Table 3 describes the summary statistics of our data for the sub-periods, 1986– 1998. The average value of growth rate of output for this period is 1.57%. Inflation has a mean value of 30%, which is higher than the full sample mean. Openness of the economy has average value 53.92%, this result indicates a remarkable improvement in export-import activities in Nigeria during the period 1986 - 1998. The average growth rate of population for the period is 2.55. Logarithm of inflation has average value 3.07%.

Table 4: Descriptive statistics for the period 1999 – 2015

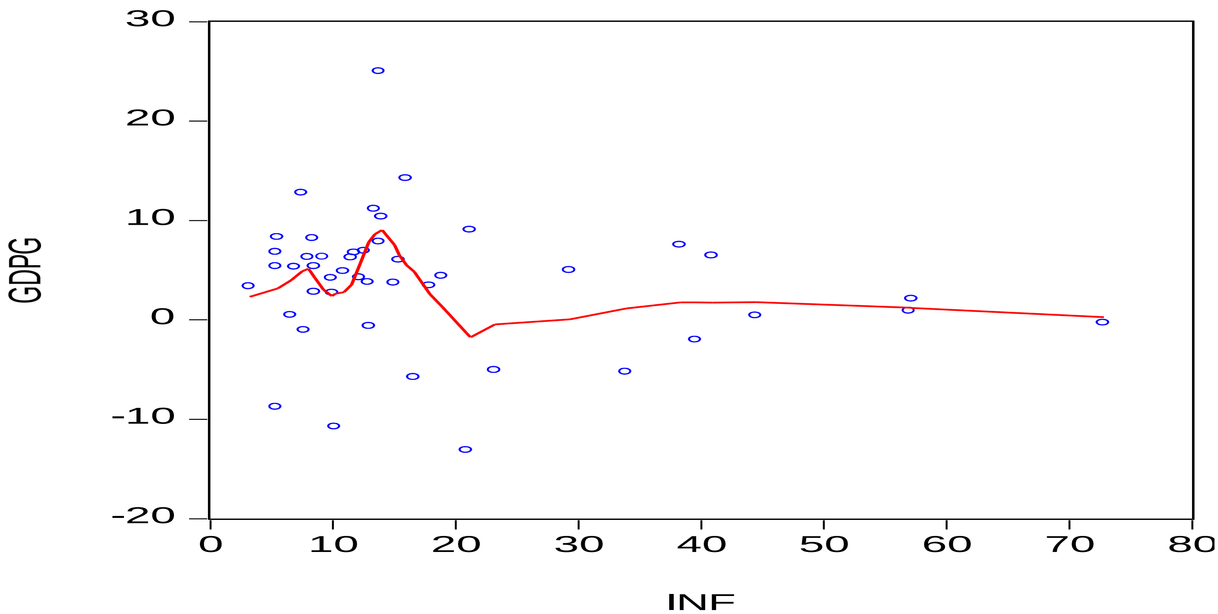
	GDPG	INF	OPNS	POPGR	LINF
Mean	5.58	11.34	55.03	2.61	2.37
Max.	10.35	18.90	81.81	2.69	2.94
Min.	0.47	5.40	30.98	2.51	1.68
Std Dev.	2.24	3.09	15.51	0.07	0.36
Obs.	17	17	17	17	17

Table 4 describes the summary statistics of our data for the sub-periods, 1999 – 2015. The average value of growth rate of output for this period is 5.58%. Inflation has a mean value of 11%, which is smaller than the other sub-periods. Openness of the economy has average value 55.03%; this result also indicates a remarkable improvement in export-import activities in Nigeria during the period 199 - 2015. The average growth rate of population for the period is 2.61%. Logarithm of inflation has average value 2.37%.

Evidently, the period 1998 – 2015 recorded lowest average inflation rate and highest output growth, the period 1986 – 1998 recorded the high level of inflation rate and lowest output growth. These results tend to corroborate the assertion that low inflation leads to high output growth, while high inflation is inimical to output growth. This relationship has been translated into the use of threshold models, which suggest that when inflation exceeds the threshold, its impact on output growth becomes injurious (Sergii, 2009; Doguwa, 2013).

To further justify our use of threshold model, we also plot a scatter with nearest neighbor fit showing the relationship between output growth and inflation rate for the full sample period. The result is shown below:

Figure 1: Inflation - Output Growth Nexus for the period 1970 - 2015



Evidently, the relationship between output growth and inflation is not deterministic; hence the use of nonlinear model is appropriate. In the steps that follow, we analyze each of the sample periods. Specifically, we probe the time series properties of the variables for each period, investigate the issue of endogeneity in our model, test for cointegration and then estimate the threshold level of inflation. We begin with the full sample (1970 – 2015).

The Period 1970 - 2015

Unit Root Test

The result of the unit root test using the ADF approach is presented in the table 5.

Table 5: The summary of stationarity test results

Augmented-Dickey Fuller Test				
	LEVEL		FIRST DIFFERENCE	
Variables	Intercept	Intercept + trend	Intercept	Intercept+ Trend
gdpg	-6.1971***	-5.4574***		
Inf	-3.3119**	-3.1869		
Opns	-2.6472	-2.3651	-9.0431***	-9.2765***
Popgr	-2.9133	-1.7828	-5.0278***	-4.2157***
		Critical Value		
1%	-3.5847	-4.1809	-3.5885	-4.1809
5%	-2.9281	-3.5155	-2.9297	-3.5155

Note: *** and ** denote significant at 1% and 5% levels of significance respectively

The result shows that GDP growth, inflation rate and log of inflation are I(0) processes, while openness of economy and population growth are I(1) processes. This result suggests the possibility of long run relationship among these variables; hence this is investigated in the next step. The result of our unit root test indicates a mixture of order of integration, that is I(0) and I(1) – an ideal situation for ARDL bound testing approach to cointegration.

Cointegration Test

The study adopts the ARDL Bound Testing approach proposed by Pesaran and Shin (1999) and Pesaran et al. (2001). The choice of this approach is further validated by the outcome of the unit root tests which suggest that there are mixture of I(0) and I(1) variables. To implement, we first determine the appropriate lag structure for the ARDL model in equation (5). We also make sure that the errors in model are serially independent and that the model is dynamically stable before the Bound Testing.

Table 6: lag selection results

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-122.1879	NA*	33.71084	6.350628	6.684983*	6.472381
1	-121.4299	1.183182	34.18611	6.362434	6.738584	6.499407
2	-118.9669	3.724555	31.91971*	6.291067*	6.709012	6.443260*
3	-118.9474	0.028503	33.59850	6.338898	6.798636	6.506309
4	-118.4378	0.720874	34.55574	6.362820	6.864354	6.545451

Note * indicates lag order selected by the criterion (each test at 5% level of significant)

Three test criteria, Akaike information criterion (AIC), Final prediction error (FPE) and Hannan-Quinn information criterion (HQ) select a two-period lag length. Accordingly, the study adopts a two period lag model.

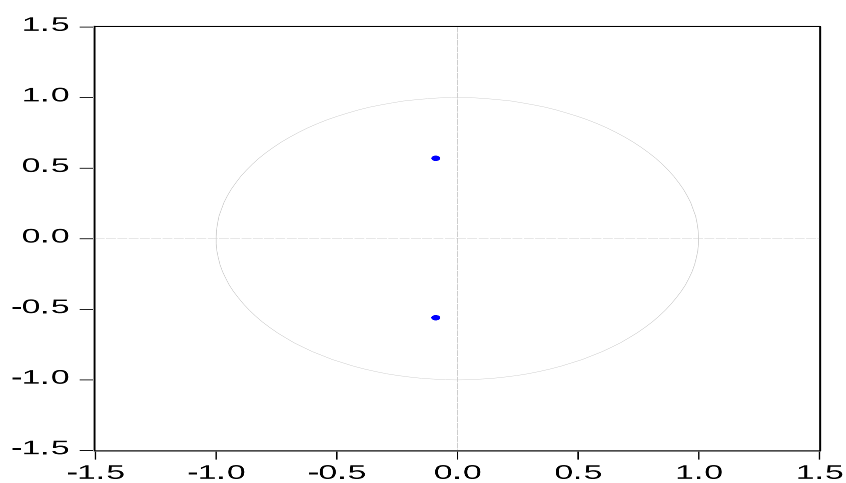
The autocorrelation test shows that the error terms are serially independent (see result below) up to lag four.

Table 7: Serial Correlation Results

Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order h		
Lags	LM-Stat	Prob
1	2.094860	0.1478
2	0.034672	0.8523
3	0.921380	0.3371
4	0.406320	0.5238
Probs from chi-square with 1 df.		

Next, we test for the model stability. The inverse roots of each of the associated characteristic equations (see the inverse roots of AR/MA polynomial(s) below), suggests that the AR (2) model is dynamically stable since these roots are all inside the unit circle.

Figure 2. Inverse Roots of AR Characteristic Polynomial



Given that the AR (2) model is dynamically stable and the errors are serially independent, we then proceed to perform the bound testing.

Under the null hypothesis of absence of a long-run equilibrium relationship among the variables, that is:

H_0: Φ1= Φ2= Φ3 = Φ4 = 0, the alternative (H_1) is true if Φ1= Φ2= Φ3 = Φ4 ≠ 0.

Decision rule:

Case 1: Reject H_0 if the F-value is greater than the upper bound.

Case 2: Accept H_0 if the F-value is less than the lower bound.

Case 3: Inconclusive if the F-value falls between the lower and upper bounds.

Table 8. Wald Test

Equation: Untitled			
Test Statistic	Value	df	Probability
F-statistic	3.535486	(4, 33)	0.0165
Chi-square	14.14194	4	0.0069
Null Hypothesis: C(7) = C(8) = C(9) = C(10) = 0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(7)		-0.838443	0.251446
C(8)		0.003480	0.060986
C(9)		0.106436	0.061928
C(10)		0.502302	5.796044

The Wald test returns F-value of 3.54 (see the Wald coefficient test above). The critical value is obtained from table CI(iii) page 300 of the Pesaran et al (2001).

We have (K + 1 = 4) variables. The lower and upper bounds for F-test at 5% and 10 significance level are [2.86, 4.01] and [2.45, 3.52] respectively.

Comparing the F-calculated and the values of the F-critical at different level of significance shows that null hypothesis of no cointegration cannot be rejected at 5%. However, at 10% significant level, the null hypothesis is rejected. Hence we conclude that the variables are cointegrated are therefore share long-run relationship.

Following this conclusion, we estimate an error model to account for the short-run dynamics and then gauge the rate at which the perceived disequilibrium in the short-run adjusts to long run equilibrium. The result is shown below:

Table 9: Error correction estimates: the short-run dynamics
Dependent variable: Δ(GDPG)

Variable	**Coefficient**	**Standard error**	**t-statistics**
VECt	-0.420409***	0.19831	-2.11996
Δ(GDPG(-1))	-0.429300***	0.15917	-2.69706
Δ(GDPG(-2))	-0.380119***	0.11912	-3.19100
Δ(INF(1))	0.113351	0.06232	1.81897
Δ(INF(-2))	0.112361	0.06425	1.74868
Δ(OPNS(-1))	0.015422	0.08480	0.18187
Δ(OPNS(-2))	-0.068068	0.08075	-0.84295
Δ(POPGR(-1))	30.14282	32.0746	0.93977
Δ(POPGR(-2))	-22.50321	30.50321	-0.72813
Constant	-0.159748	0.83192	-0.19202
R^2 = 0.61	***F- statistics = 5.72***		

*** denotes significant at 5% level

The error correction result confirms the existence of long run relation among the variables. The error term is rightly signed with a value of -0.42 and is statistically significant at the 5 percent significance level. This suggests that about 42 percent of the disequilibrium in the model is corrected within one year.

Table 10: Granger causality

H_0: GDPG does not granger cause variable

Null hypothesis	Obs.	P-value
GDPG does not granger cause INF	44	0.36
GDPG does not granger cause OPNS	44	0.71
GDPG does not granger cause POPGR	44	0.39
GDPG does not granger cause LINF	44	0.12

We apply Granger test in order to test the exogeneity assumption of our regressors. The result shows that we cannot reject the null hypothesis, which means that growth does not Granger cause inflation, logarithm of inflation, growth rate of population, and openness of the economy.

Inflation threshold Estimation

We estimate the inflation threshold for our full sample spanning from 1970 – 2015 and then each of the three sub-periods.

Table 11: Estimation of threshold level from 1970 – 2015

Variable	**k = 10%**	**k = 11%**	***k = 12%***	**k = 13%**	**k = 14%**
C	34.72***	35.66***	36.08***	35.70***	35.75***
	(16.39)	(16.36)	(16.33)	(16.32)	(16.34)
	[2.12]	[2.18]	[2.21]	[2.19]	[2.19]
INF	0.79	0.70	0.60	0.49	0.42
	(0.65)	(0.53)	(0.44)	(0.38)	(0.34)
	[1.23]	[1.32]	[1.36]	[1.29]	[1.25]
Dum(INF – K)	-0.93	-0.85***	-0.76	-0.65	-0.59
	(0.68)	(0.34)	(0.48)	(0.42)	(0.38)
	[-1.37]	[2.50]	[-1.58]	[-1.56]	[-1.55]
OPNS	-0.02	-0.02	-0.01	-0.01	-0.01
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
	[-0.27]	[-0.26]	[-0.24]	[-0.19]	[-0.14]
POPGR	-13.78***	-13.99***	-13.96***	-13.55***	-13.42***
	(6.54)	(6.49)	(6.43)	(6.37)	(6.35)
	[-2.11]	[-2.16]	[-2.17]	[-2.13]	[-2.11]
	R^2 = 0.14	**R^2 = 0.15**	**R^2 = 0.15**	**R^2 = 0.15**	**R^2 = 0.15**
	RSS = 1672	**RSS = 1657**	**RSS = 1648**	**RSS = 1651**	**RSS = 1652**

Note: *** denotes significant at 5%, standard error in ( ) and t-statistics in [ ].

The threshold estimate for the full sample (1970 – 2015) is presented in the table above. We began the search for threshold level of inflation from 5% to 20%. Because of space, we present only the identified threshold level alongside two inflation regimes before and after the threshold level. From the above result a statistically insignificant threshold level of inflation of 12% is identified. Though, insignificant, this represents the level beyond which the impact of inflation on output growth becomes injurious. Below this level, inflation exerts positive impact on output growth as indicated by the coefficient of inflation of about 0.60. The size of this coefficient shows that a unit increase in inflation will cause output to expand by 0.60 units. As inflation rises above the threshold level, 12%, the effect assumes negative as indicated by {the sum of $\Pi1 + \Pi2 \equiv 0.60 + (-0.76) = -0.16$}. This result suggests that a unit rise in inflation above the threshold level of 12%, output growth contracts by about 0.16 units.

Table 12: Estimation of threshold level from 1970 – 1985

Variable	**k = 9%**	**k = 10%**	***k = 11%***	**k = 12%**	**k = 13%**
C	3.61	7.45	11.21	13.46	12.76
	(29.50)	(28.45)	(28.14)	(28.23)	(28.63)
	[0.12]	[0.26]	[0.40]	[0.48]	[0.45]
INF	3.03***	2.49***	2.01***	1.60***	1.27
	(1.36)	(1.07)	(0.87)	(0.75)	(0.65)
	[02.22]	[2.32]	[2.26]	[2.13]	[1.95]
Dum(INF – K)	-3.77***	-3.26***	-2.81***	-2.41***	-2.09***
	(1.51)	(1.22)	(1.04)	(0.90)	(0.81)
	[-2.50]	[-2.67]	[-2.71]	[-2.67]	[-2.58]
OPNS	-0.68	-0.67	-0.62	-0.59	-0.58
	(0.37)	(0.36)	(0.35)	(0.35)	(0.36)
	[-1.82]	[-1.86]	[-1.77]	[-1.68]	[-1.63]
POPGR	2.03	1.37	0.32	-0.07	0.86
	(14.76)	(14.39)	(14.32)	(14.41)	(14.59)
	[0.14]	[0.10]	[0.02]	[-0.01]	[0.06]
	R^2 = 0.56	**R^2 = 58**	**R^2 = 58**	**R^2 = 57**	**R^2 = 0.57**
	RSS = 564	**RSS = 536**	**RSS = 530**	**RSS = 537**	**RSS = 576**

Note: *** denotes significant at 5%, standard error in ( ) and t-statistics in [ ].

Between the period 1970 and 1985 (the pre-SAP period), a statistically significant inflation level of 11% is found. The threshold level of inflation at 11% indicates the break-even level of inflation, above which inflation has a higher negative impact on the growth rate of output. On average, for inflation rates higher than the 11% threshold level, growth rate was hindered by 0.8 (-2.81 + 2.01 = -0.8) annually during the sample period. This implies that once the baseline level (of inflation) is reached, a unit increase in inflation will hinder output growth by about 0.8 units.

The coefficient of inflation level (Π_1) is positive and statistically significant. This is in tandem with theory that low inflation promotes output growth. On average, for inflation rates lower than the 11%, growth improves by 2.01%.

Table 13: Estimation of threshold level from 1986 – 1998

Variable	k = 5%	k = 6%	*k = 7%*	k = 8%	k = 9%
C		-130.17	-79.01	-77.84	-94.55
		(134.39)	(124.70)	(130.93)	(131.51)
		[-0.97]	[-0.63]	[-0.59]	[-0.72]
INF	-16.89	15.17	5.12***	1.58	-0.72
	(24.61)	(16.79)	(2.32)	(4.13)	(1.88)
	[-0.69]	[0.90]	[2.21]	[0.38]	[-0.38]
Dum(INF – K)	16.94	-15.16	-5.68***	-1.55	0.81
	(24.65)	(16.84)	(1.83)	(4.19)	(1.95)
	[0.69]	[-0.90]	[-3.11]	[-0.37]	[0.41]
OPNS	0.22	0.58***	0.08	0.16	0.27
	(0.17)	(0.23)	(0.23)	(0.24)	(0.21)
	[1.32]	[2.52]	[0.36]	[0.66]	[1.29]
POPGR	28.43	14.38	14.31	22.60	33.92
	(45.51)	(48.57)	(48.55)	(50.41)	(49.58)
	[0.62]	[0.30]	[0.29]	[0.45]	[0.68]
	R^2 = 0.18	**R^2 = 0.26**	**R^2 = 0.27**	**R^2 = 0.20**	**R^2 = 0.19**
	RSS = 382	**RSS = 347**	**RSS = 347**	**RSS = 376**	**RSS = 380**

Note: *** denotes significant at 5%, standard error in ( ) and t-statistics in [ ].

For the period 1986 to 1998 (the post-SAP period), a statistically significant inflation level of 7% is identified. The threshold level of inflation at 7% indicates the break-even level of inflation, above which inflation has a higher negative impact on the growth rate of output. On average, for inflation rates higher than the 7% threshold level, growth rate i***s*** hindered by 0.56 (-5.68 + 5.12 = -0.56) annually during the sample period. This implies that once the baseline level (of inflation) is reached, a unit increase in inflation will cause output contraction by about 0.56 units.

The coefficient of inflation level (Π_1) is positive and statistically significant. This is in tandem with theory that low inflation promotes output growth. On average, for inflation rates lower than the 7%, growth improves by 5.12%.

Table 14: Estimation of threshold level from 1999 – 2015

Variable	k = 6%	k = 7%	*k = 8%*	k = 9%	k =10%
C	-64.73	-66.88***	-60.56***	-54.14	-53.16
	(43.52)	(30.85)	(26.61)	(27.08)	(29.10)
	[-1.49]	[-2.17]	[-2.28]	[-2.10]	[-1.83]
INF	0.84	0.95	0.96***	0.58	0.21
	(4.26)	(1.56)	(0.33)	(0.66)	(0.52)

	[0.20]	[0.61]	[2.91]	[0.88]	[0.40]
Dum(INF – K)	-0.90	-1.05	-1.15***	-0.80	-0.38
	(4.34)	(1.64)	(0.30)	(0.83)	(0.75)
	[-0.21]	[-0.64]	[-3.83]	[-0.98]	[-0.50]
OPNS	0.09***	0.09	0.10***	0.09***	0.08
	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)
	[2.25]	[2.10]	[2.21]	[2.25]	[1.90]
POPGR	23.25***	23.42***	20.63***	19.24	20.11
	(10.40)	(9.93)	(9.71)	(10.28)	(11.17)
	[2.23]	[2.36]	[2.12]	[1.87]	[1.80]
	R^2 = 0.31	**R^2 = 0.34**	**R^2 = 0.37**	**R^2 = 0.36**	**R^2 = 0.32**
	RSS = 55	**RSS = 53**	**RSS = 50**	**RSS = 51**	**RSS = 54**

Note: *** denotes significant at 5%, standard error in ( ) and t-statistics in [ ].

For the period 1999 to 2015 (the era of civil rule), a statistically significant inflation level of 8% is identified. The threshold level of inflation at 8% indicates the break-even level of inflation, above which inflation has a higher negative impact on the growth rate of output. On average, for inflation rates higher than the 8% threshold level, growth rate is reduced by 0.19 units (-1.15 + 0.96 = -0.19) annually during the sample period. This implies that once the baseline level (of inflation) is reached, a unit increase in inflation will cause output contraction by about 0.19 units. The coefficient of inflation level (Π_1) is positive and statistically significant. This is in tandem with theory that low inflation promotes output growth. On average, for inflation rates lower than the 8%, growth improves by 0.96 units.

Test for Structural Break (Parameter Stability)

We estimated the inflation threshold for the period 1970 – 2015, on the assumption that there is no structural break. Relaxing this likely assumption, we divide our sample data into three time periods: 1970–1985, 1986 – 1998 and 1999 – 2015 to capture the pre-SAP era, the post-SAP era and the civil rule era respectively. Thus, we have four possible regressions. Here, we conduct a formal test for likely breaks in Nigerian economy over the period 1970 – 2015. Because the possible breakpoints are known, we employ the chow test.

Under the null hypothesis of no structural break or change (parameter stability), we reject the null if the F-calculated is greater than the F-critical.

The F-calculated is given by: $$\frac{(RSS_R - RSS_{UR}) / K}{(RSS_{UR}) / (n_1 + n_2 + n_3 - 3k)}$$

1970 – 2015: RSS_R = 1648 with ($n_1 + n_2 + n_3 - k$) df = (46 – 4) = 42

1970 – 1985: RSS_1 = 530 with ($n_1 - k$) df = (16 – 4) = 12

1986 – 1998: RSS_2 = 347 with ($n_2 - k$) df = (13 – 4) = 9

1999 – 2015: $RSS_3 = 50$ with $(n_3 - k)$ df = (17 – 4) = 13

$RSS_{UR} = (RSS_1 + RSS_2 + RSS_3) = 927$ with $(n_1 + n_2 + n_3 - 3k) = (46 - 12) = 34$

Where: RSS_{UR} and RSS_R are unrestricted and restricted sum of square residuals, which are the RSS at the various identified threshold levels of inflation.

Substituting the above values in their appropriate places in the above formula yields an F-calculated value of 6.61.

From the tables, we obtain F-critical value of 4.02, using:

$F\alpha \{K, (n_1 + n_2 + n_3 - 3k)\} = F_{0.01} \{4, 34\}$.

Based on the result, the null hypothesis of no structural change is rejected. Hence, the conclusion that there is structural change, this implies that the parameters are not stable over time.

DISCUSSION OF FINDINGS

This study is motivated by the need to estimate the threshold level of inflation in Nigeria across regimes. Though various empirical studies have investigated this topical issue in Nigeria and found different threshold levels of inflation. In approach, almost all of the studies did not take cognizance of the possible structural changes take have taken place in Nigeria. Hence, they estimated the threshold level of inflation ignoring this likely possibility. To account for this, we estimated the threshold level of inflation for Nigeria, using data set from four different time periods (1970 - 2015; 1970 – 1985; 1986 – 1998 and 1999 – 2015).

The summary statistics indicate that the mean of the variables are not the same across regimes. For instance, the mean values of output growth and inflation for the full sample period (1970 – 2015) are 3.83% and 18.37% respectively, this result is quite similar to the mean values of output growth and inflation (3.83% and 16.09% respectively) obtained for the period 1970 – 1985. Between 1986 and 1998, growth averaged 1.57% and average inflation rate for this period was 30.35%, while the average growth and inflation were 5.58% and 11.34% respectively. These findings lead credence that high inflation rate is contractionary.

We apply Granger test in order to test the exogeneity assumption of our regressors. Evidently, the result shows that there is a unidirectional relationship between output growth and each of the regressors. The cause-effect relationship flows from the regressors (inflation, growth rate of population and openness of the economy) to output growth. This finding is consistent with the model assumption and in line with the earlier study by Sergii (2009). The cointegration analysis reveals that the variables of the models share long-run relationship; hence, there are policy variables. The study also found clear evidence of structural changes, hence estimating a threshold level of inflation, disregarding this may lead to loss of precision in estimation.

Using a threshold regression model developed by Khan and Senhadji (2001), the study found different inflation threshold levels for Nigeria across periods. While statistically insignificant inflation threshold of 12% was found for the full sample (1970 – 2015), statistically significant threshold levels of 11%, 7% and 8% were found for the periods 1970 – 1985, 1986 – 1998 and 1999 – 2015 respectively. These results are somehow close to the threshold level estimated by Salami and Kelikume (2010) and Ajide and Lawanson (2011). But differ significantly from the result obtained by Bassey and Onwioduokit (2011).

CONCLUSION AND POLICY RECOMMENDATIONS

This study re-examined the inflation-growth relationship in Nigeria. We used annual data set, which covered four time periods: 1970 – 2015; 1970 – 1985; 1986 – 1998 and 1999 – 2015. Our empirical findings support postulation that threshold level exists in non-linear inflation-growth relationship. Moreover, inflation has favorable effect on growth if it is less than this threshold and impedes growth otherwise. We estimated threshold levels of 12%, 11%, 7% and 8% for each of our time period respectively. From this finding, the conclusion that inflation threshold differs across regimes emerges. The implication of this findings is that relying on a large number of periods (time series samples) in estimating threshold level of inflation, especially in the presence of obvious structural breaks, may yield misleading result. And the policy makers may be targeting the *wrong thing*. Again, the finding indicates that low inflation rate (below the threshold level) promotes economic growth while high inflation (above the threshold level) is inimical to economic growth. The results also suggest that as the economy advances, the threshold level of inflation reduces. This is in tandem with the unconventional rule that hypothesizes optimal inflation rate of 5% for developed economies and about 10% - 11% for developing economies. Accordingly, the study recommends that the policy makers should monitor inflation closely and choose an optimal target for inflation, which is consistent with long-term sustainable economic growth of the economy. Further, to ensure precision in threshold estimation, the authority should take cognizance of the prevailing macroeconomic environment, otherwise, the value will be either under- or over- estimated.

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