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Threshold Effect of Inflation on Economic Growth in Nigeria

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It is widely believed that price stability promote long-term economic growth, whereas high inflation is inimical to growth. This paper utilized a quarterly time series data for the period 1981 – 2009 to estimate a threshold level of inflation for Nigeria. Using a threshold regression model developed by Khan and Senhadji (2001), the study estimated a threshold inflation level of 13 per cent for Nigeria. Below the threshold level, inflation has a mild effect on economic activities, while above it, the magnitude of the negative effect of inflation on growth was high. The negative and significant relationship between inflation and economic growth for inflation rates both below and above the threshold level is robust with respect to changes in econometric methodology, additional explanatory variables and changes in data frequency. These finding are essential for monetary policy formulation as it provide a guide for the policy makers to choose an optimal target for inflation, which is consistent with long-term sustainable economic growth goals of the country.

Key words: Inflation, Growth, Threshold

JEL Classification: E31, 040

1.0 Introduction

Rapid output growth and low inflation are the most common objectives of macroeconomic policy in both developed and developing economies. In Nigeria, the formulation and implementation of monetary policy by the Central Bank of Nigeria (CBN) was aimed at maintaining price stability which is consistent with the achievement of sustainable economic growth. The monetary authority strives to achieve the government's overall inflation objective through effective monetary management, which entails setting intermediate and operating targets in tandem with the assumed targets for GDP growth, inflation rate and balance of payments.

The growing interest in price stability as a major goal of monetary policy is an acknowledgement of the observed phenomenon that high inflation disrupts the smooth functioning of a market economy. High inflation is known to have many adverse effects: it imposes welfare costs on the society; impedes efficient resource

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allocation by obscuring the signaling role of relative price changes; discourages savings and investment by creating uncertainty about future prices; inhibits financial development by making intermediation more costly; hits the poor excessively, because they do not hold financial assets that provide a hedge against inflation; and reduces a country's international competitiveness by making its exports relatively more expensive, thus impacting negatively on the balance of payments, and perhaps more importantly, reduces long-term economic growth (See Ghosh and Phillips, 1998; Khan and Senhadji, 2001; Billi and Khan, 2008; Frimpong and Oteng-Abayie, 2010). Overall, businesses and households are thought to perform poorly in periods of high and unpredictable inflation, Barro (1996).

Most policymakers, however, agree that they should not allow inflation to fall below zero because the costs of deflation are thought to be high, Billi and Khan (2008). Even though some evidence suggests that moderate inflation helps in economic growth, Mubarik (2005), the overall weight of evidence so far clearly indicated that inflation is inimical to growth. Consequently, policymakers should aim at a low rate of inflation that maximizes general economic well-being. But how low should inflation be in Nigeria? Should the target inflation be 10 per cent or 5 per cent? How much inflation impedes economic growth in Nigeria?

A considerable amount of literature examining the relationship between inflation and economic growth in both developed and developing economies are available. However, several of those studies focused specifically on whether the relationship between inflation and long-run growth is negative and a nonlinear one – positive or nonexistent relationship at low rate of inflation but becomes negative at higher rates, see Fischer (1993) who first identified the relationship. If such a nonlinear relationship exists, then it should be possible, in principle, to estimate the inflexion point, or a threshold, at which the sign of the relationship between the two variables would switch. Consequently, Khan and Senhadji (2001) produced the threshold level for both developed and developing countries in a cross-country panel data framework. The authors arrived at a threshold level range of 11 - 12 per cent for developing countries, including Nigeria. Even though cross-country studies were justified based on their ability to generalize empirical findings, specific country studies can provide specific evidence relevant for the country under study, as Kremer *et al.* (2009) suggested that inflation threshold in non-industrial countries and the appropriate level of inflation target might be country-specific. This becomes necessary due to heterogeneous factors obtainable in different countries. Although Chimobi (2010) examined the relationship between

inflation and growth in Nigeria, no attempt was made to provide an optimal inflation rate for policy decisions. Fabayo and Ajilore (2006) arrived at a threshold level of 6 per cent for Nigeria using annual data from 1970 – 2003. However, Bruno and Easterly (1998) argue that the negative relationship between inflation and growth, typically found in cross-country regressions, exists only in high frequency data and with extreme inflation observations, which Khan and Senhadji (2001) confirmed that the extent of the relationship is stronger at high frequencies.

This paper follows the Khan and Senhadji (2001) methodology in providing evidence of a threshold level of inflation in Nigeria; beyond which inflation exert a negative impact on economic growth. The study goes beyond the works of Chimobi (2010) and Fabayo and Ajilore (2006) by extending the analysis to the estimation of the threshold effect of inflation on growth in Nigeria, using quarterly time-series data for the period 1981 – 2009.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature on inflation and growth and the theoretical framework for the study; Section 3 outlines the threshold model; Section 4 presents the estimation results of the threshold model; Section 5 concludes.

2.0 Literature Review and Theoretical Framework

2.1 Literature Review

This section examines past and related research studies on the relationship between inflation and economic growth both in Nigeria and in other economies of the world with particular interest on data used, methodology adopted, nature of the relationship and the estimated inflation thresholds. Most studies on the threshold effect of inflation on economic growth are dominated by cross-country panel studies (Sarel, 1996; Khan and Senhadji, 2001; Mallik and Chowdhury, 2001; and Kremer *et al*., 2009). On the other hand, due to the peculiarity of certain economies, especially developing economies, specific country studies might reveal specific evidences fundamental to the country under study. This is what instigated the study. In this regard, we identified some country specific studies, especially on developing countries, on the inflation-economic growth nexus, which include Ahmed and Mortaza (2005) for Bangladesh; Hussain (2005) and Mubarik (2005) for Pakistan; Singh (2003) for India; Hodge (2005) for South Africa; Fabayo and Ajilore (2006) and Chimobi (2010) both for Nigeria and Frimpong and Oteng-Abayie (2010) for Ghana.

Sarel (1996) examined the non-linear effects of inflation on economic growth using annual panel data on GDP, CPI, population, terms of trade, real exchange rate, investment rates and government expenditures of 87 countries from 1970-1990. The 20 year sample period was divided into four equal periods of five years each, obtaining a total of 248 observations for the study. He found a significant structural break (inflation threshold) in the function that relates economic growth to inflation. The threshold was estimated at 8 per cent, below which inflation did not have any effect on economic growth or it may have a slight positive effect. When it rose above the 8 per cent threshold, however, the estimated effect of inflation was significant, robust and extremely powerful. He demonstrated that when the existence of the structural break is ignored, the estimated effect of inflation on economic growth for higher inflation rates decreased by a factor of three.

Khan and Senhadji (2001) re-examined the issue of the existence of threshold effects in the relationship between inflation and economic growth using a new econometric technique that allows for appropriate estimation procedures and inference. They utilized an unbalanced panel dataset covering the period 1960-1998 from 140 countries, comprising industrialized and developing countries. They estimated inflation threshold levels of 1-3 per cent and 11-12 per cent for industrialized and developing countries, respectively. The empirical results suggested that beyond threshold levels of 3 and 12 per cent for industrialized and developing countries, respectively, the relationship between inflation and economic growth became negative. The authors noted that the peculiarities of industrialized economies remained different from those of the developing economies. However, they did not acknowledge the peculiarities existing among developing countries in terms of resources base, population size, level of corruption, poverty level, etc.

Mallik and Chowdhury (2001) studied the relationship between inflation and GDP growth for four Asian countries, namely, Bangladesh, India, Pakistan and Sri Lanka. The study used un-even sample size of 1974-97 for Bangladesh, 1961-97 for India, 1957-97 for Pakistan and 1966-97 for Sri Lanka. The variables used for the study were CPI and real GDP to measure inflation rates and economic growth, respectively. They found evidence of a long-run positive relationship between inflation and GDP growth rate for all the four countries with significant feedbacks. According to the authors, moderate inflation level helps economic growth but faster growth feedbacks into inflation, thus, the countries are on a 'knife-edge'. However, this study did not estimate what the moderate inflation

rate (threshold level) that will help economic growth in the four countries should be.

A study by Kremer *et al*. (2009) using panel data from 63 countries (comprising industrial and non-industrial countries) confirmed the effect of inflation on long-term economic growth. Their findings revealed that inflation affected growth when it exceeded 2 per cent threshold for industrial countries and 12 per cent for non-industrial countries, and that below these levels the relationship between inflation and economic growth was significantly positive. However, they suggested that the inflation threshold in non-industrial countries and the appropriate level of inflation target might be country specific. Therefore, they recommended that the identification of country specific threshold might provide useful information about the appropriate location and width of an inflation targeting band. The authors' recommendation is valid because it is indeed an important policy issue for economies adopting or planning to adopt inflation targeting approach to monetary management such as Nigeria to study the relevant threshold level to serve as a guide.

In Bangladesh, Ahmed and Mortaza (2005) found a statistically significant long-run negative relationship between inflation and economic growth using annual data on real GDP and CPI covering the period 1980 to 2005. The study utilized co-integration and error correction models. They estimated an inflation threshold level of 6 per cent (structural-break point) above which inflation will adversely affect economic growth. They concluded that their findings have direct relevance to the conduct of monetary policy by the Bangladesh Bank.

Hussain (2005) and Mubarik (2005) examined inflation and growth in Pakistan using annual time series data for the periods 1973-2005 and 1973-2000, respectively; and estimated the threshold levels of inflation to be 4-6 per cent and 9 per cent, respectively, beyond which inflation will deter economic growth. Similarly, Singh (2003) suggested an inflation threshold range of between 4-7% for India. We note that both Pakistan and India are developing countries but the findings of the authors differ significantly from the findings of Khan and Senhadji (2001) and Kremer *et al.* (2009) for developing countries. This might be partly because of difference in methodology adopted or data set used. This reiterate the validity of Kremer *et al*. (2009) recommendation that conduct of country specific study due to peculiarities of economies would reveal more useful information.

Hodge (2005) conducted a study on the relationship between inflation and growth in South Africa in order to test whether South African data support the findings of

cross-section studies that inflation has long-run negative effect on growth and if higher growth can be gained at the cost of higher inflation in the short-run. According to Hodge (2005), inflation drags down growth over the long-term, while in the short run growth above its trend requires accelerating inflation. It is generally noted in literatures that high inflation has negative impact on economic growth in the long run and relates positively in the short run. Therefore, Hodge (2005) would have estimated a threshold at which authorities needed to take measures to ensure inflation does not hamper economic growth.

Fabayo and Ajilore (2006) in their paper titled "inflation – How Much is too Much for Economic Growth in Nigeria" using annual data from 1970-2003 suggested the existence of threshold inflation level of 6 per cent for Nigeria. They explained that above this threshold, inflation retards growth performance of the economy while below it, the inflation-growth relationship is significantly positive. They suggested that the goal of macroeconomic management in Nigeria should be to bring down inflation to a moderate single digit of 6 per cent (optimal inflation target policy). Our study will build on what Fabayo and Ajilore (2006) has done though we will use quarterly series (high frequency data). This is because Nigerian data are highly volatile especially inflation rate, exchange rate, etc; thus, we expect better explanation to when inflation will endanger economic growth in Nigeria. Moreover, the negative relationship between inflation and growth holds mostly in high frequency observations (See Bruno and Easterly, 1998)

Also, Chimobi (2010) used Nigerian data on CPI and GDP for the period 1970-2005 to examine the existence or not, of a relationship between inflation and economic growth and its causality. He adopted the Johansen-Juselius co-integration technique and Engle-Granger causality test. A stationarity test was carried out using Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests and stationarity was found at both 1 and 5 per cent level of significance. After testing for causality at two different lag periods (lag 2 and lag 4), he found the result suggesting unidirectional causality running from inflation to economic growth. Thus, the study maintained that the unidirectional causality found is an indication that inflation indeed impacts on economic growth. However, this study did not estimate or suggest any threshold level at which the impact could be positive or negative, significant or not, in the long run or short run. Thus, a study that attempt to estimate the inflation threshold level would have added to the debate especially that most economies are turning towards adopting inflation targeting.

Frimpong and Oteng-Abayie (2010) attempted to find out whether inflation is harmful or not; and if it is at what level does it become harmful to economic growth in Ghana. They adopted a threshold regression model designed to estimate the inflation thresholds instead of imposing them, using annual data on CPI and GDP covering 1960-2008. They found evidence of threshold effect of inflation on economic growth, which was estimated at 11 per cent. Below this level, inflation is likely to have mild effect on economic growth, while above it inflation would significantly hurt economic growth. They concluded that the current medium term inflation target of 6-9 per cent annual average set by the Bank of Ghana and the Government is in the right direction as it is below the estimated 11 per cent threshold.

Empirically, evidence from the literature suggest that any developing country with actual level of inflation of about 11 per cent (maximum) is very likely to record sustained growth in its output level (GDP) and will surely perform better with a single-digit inflation rate. This indeed reiterated why the West African Monetary Zone (WAMZ) convergence criteria prescribed single-digit inflation rate to be achieve by member countries, of which Nigeria is one.

2.2 Theoretical Framework

Economic theorization has reached varying conclusions about the relationship between output growth and inflation. Theories are viewed to be useful because they account for some observed phenomenon. Historically, there were several inflation-growth theories ranging from pre-world war era where the term 'persistent inflation' was absent – theories were built on cyclical observations to post world war era when inflation was described as a "lazy dog", or having linear, non-linear, positive, negative, short run, or long run relationship with economic growth.

The classical growth theory was laid by Adam Smith, who postulated a supply side driven model of growth, and production function where output (Y) depends on labour (L), capital (K) and land (T). That is $Y = f(L, K, T)$.

Consequently, he argued that output growth is driven by population growth, investment, land and increase in overall productivity. He viewed savings as the creator of investment and hence growth; and income distribution determines how fast or slow a nation's economy grows. However, he implicitly suggested a negative relationship between inflation and growth.

The Keynesians in their traditional model illustrated the inflation-growth nexus using the aggregate demand (AD) and aggregate supply (AS) curves. They showed that the AS curve is upward sloping rather than vertical. If AS is vertical, changes in AD of the economy will only affect prices; but if it is upward sloping, changes in AD affects both prices and output. They argued that in the short run, changes in factors like expectations, labour, prices of other production factors and fiscal and or monetary policy drive inflation as well as output. But in the long run, those factors and the shock on the steady state of the economy result in 'dynamic adjustment' of the model through a path which exhibits initial positive inflation-growth relationship and returns to negative at the latter part of the 'adjustment path' (Dornbusch *et al.*, 1996). The model also notes that the economy does not move directly to a higher inflation rate but it follows a transitional path where it rises then falls. The negative relationship theorized for output growth and inflation often occurs in practice as ascertained by empirical literatures. Under this model, there is no permanent trade-off between the two variables.

Monetarism has several important features that focus on the long run supply side properties of the economy as opposed to short run dynamics (Dornbusch *et al*., 1996). Milton Friedman laid emphasis on several key long run properties of the economy including the quantity theory of money and neutrality of money. He proposed that inflation was the product of an increase in supply or velocity of money at a rate greater than output growth in the economy. He argued that inflation can adversely impact on capital accumulation, investment and exports, and consequently, impact on a country's growth rate. It is said that in the long run, prices are mainly affected by growth in money supply with no real effect on growth; but when money supply is higher than the output growth, inflation will result.

Theoretical framework of the Neo-classicalists demonstrates that their models can yield varying results as regards inflation-growth relationship. Tobin (1965) effect postulates that an increase in inflation can result in high output; Stockman effect proposed lower output should inflation increase; while Sidrauski (1967) showed that an increase in inflation does not affect the steady state capital stock – that is neither output nor economic growth is affected.

3.0 Econometric Methodology

3.1 The Threshold Regression Model

The threshold regression model was developed by Khan and Senhadji (2001) for the analysis of threshold level of inflation for both industrial and developing countries. The model was also applied by Mubarik (2005) and Hussain (2005) in computing the threshold inflation rate for Pakistan, and Frimpong and Oteng-Abayie (2010) for Ghana.

This study applies the model to estimate the threshold level of inflation above which inflation may affect economic growth in Nigeria.

The threshold level of inflation is based on the following equation:

$$Y_t = \beta_0 + \beta_1 P_t + \beta_2 D_t (P_t - \pi) + \beta_{2+i} X_{it} + \mu_t \qquad (1)$$

where economic growth and inflation are computed as: $Y_t = \Delta \ln(RGDP)$; $P = \Delta \ln(CPI)$ and RGDP and CPI denote real gross domestic product and consumer price index, respectively; P_t is inflation, π is the threshold level of inflation, and μ_t is a random error term. The quarterly growth rates of RGDP and inflation used in the analysis were computed by taking the first difference of the current and the corresponding quarter values of RGDP and CPI i.e. current quarter value of the current year less the corresponding quarter value of the previous year. This is mathematically presented as $Y_t – Y_{t-4}$ where Y_t is the current quarter and Y_{t-4} is the corresponding quarter value. The variable X_{it} is a vector of control variables. The growth rate of gross domestic investment (INV), considered to be an important determinant of economic growth, was the only variable included as a control variable in the main threshold regression model. Other variables, which were included in the sensitivity analysis as control variables to check for the impact of additional explanatory variables, were Openness to foreign trade (OPNES), Financial Deepening (FINDEEP) and Population growth (POP). The growth rates of INV and POP were computed using similar method as Y_t and P. The dummy variable D_t is defined as:

$$D_t = \begin{cases} 1, P_t > \pi \\ 0, P_t \leq \pi \end{cases} \qquad (2)$$

The parameter π represents the threshold inflation level with the property that the relationship between output growth and inflation is given by: (i) β_1 representing low inflation; (ii) $\beta_1 + \beta_2$ representing high inflation. The high inflation means

that when β_2 is significant, then both $(\beta_1 + \beta_2)$ would be added to see their impact on economic growth and that would be the threshold level of inflation. By estimating regressions for different values of π which is chosen in an ascending order (that is 1, 2, 3 and so on), the optimal value of π is obtained by finding the value that minimizes the sum of squared residuals (maximizes the adjusted R^2) from the respective regressions. Inflation at this level has a significant impact on growth. (See Mubarik (2005) and Frimpong and Oteng-Abayie (2010))

3.2 Data

The model was estimated using quarterly time series data for the period 1981 to 2009 sourced from the CBN Annual Report and Statement of Accounts, CBN Statistical Bulletin and the National Bureau of Statistics Annual Abstract of Statistics. The study utilized the quarterly dataset on Consumer Price Index (May 2003=100), real GDP (1990 constant basic prices) and total investment proxied by Gross Fixed Capital Formation.

Annual growth rates of GDP, CPI and total investment were computed using log transformation method that eliminates, at least partially, the strong asymmetry in inflation distribution (Sarel, 1996). The log transformation also helps in smoothing time trend in the dataset (Mubarik, 2005) and provides best fit in the class of non-linear models (Khan and Senhadji, 2001).

4.0 Estimation Results and Discussion

4.1 Relationship between Real GDP Growth and Inflation

Nigeria has experienced high volatility in inflation rates. Historical inflation data indicated that the country has experienced three major episodes of high inflation in excess of 30 per cent since 1981. For instance, headline inflation increased to 40.7 per cent in 1984, from 23.2 per cent in 1983. The sharp increase in inflation rate was attributable to the austerity measures introduced in 1983 to stem the imminent collapse of the economy. Some of the factors adduced for this situation included import restriction and foreign exchange constraints, which led to severe shortages in the supply of goods and services. Similarly, the expected devaluation of the Naira arising from debt agreements with the International Monetary Fund (IMF), excess money growth, increase in credit to the government and worsening terms of external trade experienced by the country led to the inflationary pressures (Masha, 2000). Meanwhile, output growth deteriorated as economic growth declined by 1.1 per cent in 1984.

Even though inflation decelerated to 4.7 per cent in 1985, it increased to 56.0 and 50.5 per cent, respectively, in 1988 and 1989. This was attributed to the fiscal expansion that accompanied the 1988 budget and its initial financing by credit from the Central Bank of Nigeria (Masha, 2000), fuel price adjustments in 1988 and a significant depreciation of the naira exchange rate emanating from the implementation of Structural Adjustment Programme (SAP) – Mordi *et al.* (2007). In spite of the fact that inflation declined to 7.5 per cent in 1990, it rose to 44.8, 57.2 and 57.0 per cent, respectively, in 1992, 1993 and 1994. It reached an all-time high of 72.8 per cent in 1995. This was due to excess money supply, scarce foreign exchange and severe shortages in commodity supply, as well as continual labour and political unrest following the annulment of the June 1993 elections (Mordi *et al.*, 2007). In view of the excessive inflationary pressure, real GDP growth averaged only 1.5 per cent during the period 1992 – 1995. Since 1996, however, inflation rate has been below 30 per cent, averaging 12.7 per cent between 1996 and 2009, whereas real GDP growth averaged 5.4 per cent during the same period.

To corroborate the above position, we ran a simple regression analysis between the two major variables earlier described in the methodology: economic (real GDP) growth and inflation using quarterly data for the period 1981 – 2009.. The estimated regression results indicated an inverse relationship between inflation and economic growth. The coefficient was negative and statistically significant at the 5 per cent level. Similarly, a correlation coefficient between those two variables showed a value of -0.2, indicating that the variables were negatively related.

4.2 The Threshold Inflation Level

Following conclusions from the extant literature, the study hypothesizes that high inflation in Nigeria has an adverse effect on economic growth after it exceeds a certain limit. Khan and Senhadji (2001) estimated the threshold level of inflation above which inflation significantly slows growth at 11 per cent for developing countries, including Nigeria. Consequently, we estimate the threshold level for Nigeria within 11% ± 6% band i.e. 5 per cent to 17 per cent.

The estimation of equation (1) gives a specific value of the threshold inflation level and also measure the impact of that level on economic growth. The equation was estimated and the adjusted coefficient of determination (R^2) for each threshold level of inflation was computed. The optimal threshold level is the one

that maximizes the adjusted coefficient of determination (R^2). Table 1 reports the results of the estimation of the threshold levels.

Table 1: Estimation of Inflation Threshold Model at $\pi = 5$ to $\pi = 17$
Dependent Variable: Y_t (1981:Q1 – 2009:Q4)

π	Variable	Coefficient	Std. Errort-statistics	Probability	R^2	Adj. R^2	
	P_t	-0.0859	0.0286	-2.9969	0.0034		
5%	$D_t(P_t-\pi)$	-0.0219	0.0145	-1.5039	0.1358	0.1447	0.1188
	INV	0.1743	0.0686	2.5394	0.0127		
	C	0.0791	0.0159	4.9562	0.0000		
	P_t	-0.0829	0.0285	-2.8995	0.0046		
6%	$D_t(P_t-\pi)$	-0.0174	0.0133	-1.3072	0.1942	0.1400	0.1140
	INV	0.1671	0.0693	2.4099	0.0178		
	C	0.0744	0.0146	5.0692	0.0000		
	P_t	-0.0849	0.0291	-2.9151	0.0044		
7%	$D_t(P_t-\pi)$	-0.0091	0.0112	-0.8098	0.4200	0.1309	0.1046
	INV	0.1802	0.0691	2.6084	0.0105		
	C	0.0661	0.0125	5.2572	0.0000		
	P_t	-0.0845	0.0290	-2.9090	0.0045		
8%	$D_t(P_t-\pi)$	-0.0088	0.0110	-0.8016	0.4247	0.1308	0.1045
	INV	0.1818	0.0691	2.6279	0.0100		
	C	0.0657	0.0122	5.3603	0.0000		
	P_t	-0.0815	0.0290	-2.8099	0.0060		
9%	$D_t(P_t-\pi)$	-0.0020	0.0105	-0.1940	0.8465	0.1255	0.0990
	INV	0.1796	0.0693	2.5908	0.0110		
	C	0.0600	0.0116	5.1749	0.0000		
	P_t	-0.0827	0.0286	-2.8837	0.0048		
10%	$D_t(P_t-\pi)$	-0.0105	0.0101	-1.0454	0.2984	0.1347	0.1085
	INV	0.1811	0.0689	2.6259	0.0100		
	C	0.0660	0.0109	6.0493	0.0000		
	P_t	-0.0847	0.0284	-2.9824	0.0036		
11%	$D_t(P_t-\pi)$	-0.0178	0.0097	-1.8226	0.0714	0.1536	0.1279
	INV	0.1865	0.0683	2.7303	0.0075		
	C	0.0705	0.0104	6.7397	0.0000		
	P_t	-0.0851	0.0283	-2.9984	0.0034		
12%	$D_t(P_t-\pi)$	-0.0176	0.0095	-1.8562	0.0664	0.1546	0.1290
	INV	0.1858	0.0682	2.7223	0.0077		
	C	0.0697	0.0101	6.8980	0.0000		
	P_t	-0.0873	0.0279	-3.1197	0.0024		
13%	$D_t(P_t-\pi)$	-0.0236	0.0092	-2.5724	0.0116	0.1800	0.1551*
	INV	0.1679	0.0672	2.4963	0.0142		
	C	0.0734	0.0098	7.4497	0.0000		
	P_t	-0.0900	0.0281	-3.1991	0.0019		
14%	$D_t(P_t-\pi)$	-0.0231	0.0091	-2.5218	0.0133	0.1780	0.1531
	INV	0.1743	0.0672	2.5924	0.0110		
	C	0.0722	0.0096	7.4804	0.0000		
	P_t	-0.0885	0.0282	-3.1402	0.0022		
15%	$D_t(P_t-\pi)$	-0.0218	0.0092	-2.3527	0.0206	0.1715	0.1464
	INV	0.1712	0.0675	2.5349	0.0128		
	C	0.0701	0.0094	7.4525	0.0000		
	P_t	-0.0880	0.0283	-3.1088	0.0025		
16%	$D_t(P_t-\pi)$	-0.0203	0.0093	-2.1680	0.0326	0.1648	0.1395
	INV	0.1710	0.0678	2.5213	0.0133		
	C	0.0688	0.0093	7.3675	0.0000		
	P_t	-0.0864	0.0280	-3.0877	0.0026		
17%	$D_t(P_t-\pi)$	-0.0234	0.0093	-2.5040	0.0139	0.1773	0.1523
	INV	0.1816	0.0672	2.7014	0.0081		
	C	0.0685	0.0089	7.6792	0.0000		

From the estimated results, it is observable that at low threshold inflation levels (π<13%), the coefficient of β_2, which represent the threshold inflation dummy, was not significant in all the equations, indicating that there is a statistically insignificant relationship between the threshold dummy and economic growth. At that level, the relationship between inflation and economic growth was accounted for by the coefficient of β_1. As π increases, from 13 per cent, β_2 becomes statistically significant at the 5 per cent level, indicating a significant relationship between the threshold inflation dummy and growth. Thus, inflation and growth relationship was accounted for by $\beta_1 + \beta_2$. This implies that if inflation was below the 13 per cent threshold level, output growth would decline by the coefficient of P_t. However, if inflation increases beyond the 13 per cent threshold, economic growth would approximately change by the sum of the coefficients of P_t and P_t-π.

Consequently, the threshold level was identified at the 13 per cent level. At this level, the coefficient of determination was maximized (the Residual Sum of Squares, RSS, was minimized). The coefficient of determination, R^2, was found to be low across all the equations due to the limited number of variables included in the equations. A substantial number of variables were found to be strongly related to growth but growth theories were not explicit enough about what variables are to be included in growth regressions (Sala-i-Martin, 1997). Consequently, the inclusion of only inflation and investment rates, out of about 60 variables found to be significantly related to growth (see Sala-i-Martin, 1997) made the R^2 lower than expected.

The threshold level of inflation at 13 per cent means that this was 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 13 per cent threshold level, growth rate was hindered by 0.11 per cent (-0.0873 + -0.0236) quarterly during the sample period. To state the impact annually, approximately 1 per cent higher than the threshold level of 13 per cent will result in 0.44 per cent decline in output growth annually.

Meanwhile, the coefficient of inflation levels (β_1) has been negative and statistically significant at the 1 per cent level for all inflation threshold levels, indicating that inflation hampers output growth even at low inflation levels in Nigeria, but the effect was mild. On average, for inflation rates lower than the 13 per cent threshold level, growth rate declined by 0.08 per cent quarterly, or 0.32 per cent (compared with 0.44 per cent), annually during the sample period. The high inflation observations recorded within the sample period, particularly in the

1990s, may have largely accounted for this phenomenon. For instance, annual inflation rates, which reached 56.0 and 57.2 per cent respectively in 1988 and 1993, peaked at 72.8 per cent in 1995 before slowing down to 29.3 per cent the following year. Consequently, the relationship may have largely reflected the Bruno and Easterly (1998) and Easterly (1996) hypothesis that the negative relationship between inflation and economic growth holds only for high-inflationary economies.

Meanwhile, we found a statistically and economically significant positive relationship between investment rates and economic growth in line with theoretical and empirical growth literature. According to the estimation results, holding other things fixed, a 1 per cent increase in investment rates will result in 0.17 per cent increase in output growth at the inflation threshold level.

4.3 Robustness Checks

4.3.1 Sensitivity to Changes in Econometric Methodology

There is the possibility that, for such high frequency time series data of inflation and output growth, the causality may not, as assumed, run from inflation to growth, but the other way round. If this is the case, then the magnitude of the effect that inflation has on growth is biased. In addition, investment rates also appear endogenous, since investments rise when the economy achieves sustainable growth, since it makes the country more attractive for investments. Under this circumstance, applying the standard OLS may result in inconsistent estimates. To remedy the problem and also check the robustness of the estimated model, the threshold model was re-estimated using the Two-Stage Least Square (TSLS) estimation procedure. The set of instruments included first lags of real GDP growth, investment rates and inflation rates. The results of the TSLS regression, as produced in Table 2, also indicated a 13 per cent threshold inflation level for Nigeria. Furthermore, the coefficients of the TSLS were identical with that of the main model.

4.3.2 Sensitivity to Additional Explanatory Variables

The endogenous growth literature emphasizes that anything that enhances economic efficiency no matter what, is good for growth. In line with this, other variables that can be found in growth literature including openness to foreign trade, financial deepening and population growth were added to the main equation.

Table 2: Two-Stage Least Squares (TSLS) Estimation of the Inflation Threshold Model at $\pi = 5$ to $\pi = 17$, Dependent Variable: Y_t (1981:Q1 – 2009:Q4)

π	Variable	Coefficient	Std. Error	t-statistics	Probability	R^2	Adj. R^2
	P_t	-0.1091	0.0311	-3.5046	0.0007		
5%	$D_t(P_t-\pi)$	-0.0227	0.0147	-1.5452	0.1255	0.1333	0.1068
	INV	0.1852	0.1283	1.4432	0.1521		
	C	0.0842	0.0177	4.7381	0.0000		
	P_t	-0.1080	0.0311	-3.4720	0.0008		
6%	$D_t(P_t-\pi)$	-0.0178	0.0136	-1.3097	0.1934	0.1289	0.1022
	INV	0.1534	0.1308	1.1727	0.2438		
	C	0.0810	0.0172	4.6873	0.0000		
	P_t	-0.1110	0.0319	-3.4763	0.0008		
7%	$D_t(P_t-\pi)$	-0.0103	0.0113	-0.9101	0.3650	0.1167	0.0897
	INV	0.2010	0.1296	1.5510	0.1241		
	C	0.0716	0.0143	4.9913	0.0000		
	P_t	-0.1104	0.0318	-3.4626	0.0008		
8%	$D_t(P_t-\pi)$	-0.0100	0.0112	-0.8972	0.3718	0.1157	0.0887
	INV	0.2096	0.1298	1.6145	0.1096		
	C	0.0707	0.0138	5.0944	0.0000		
	P_t	-0.1065	0.0317	-3.3508	0.0011		
9%	$D_t(P_t-\pi)$	-0.0026	0.0106	-0.2506	0.8026	0.1115	0.0843
	INV	0.2055	0.1292	1.5908	0.1149		
	C	0.0644	0.0133	4.8323	0.0000		
	P_t	-0.1074	0.0314	-3.4216	0.0009		
10%	$D_t(P_t-\pi)$	-0.0105	0.0102	-1.0355	0.3030	0.1207	0.0938
	INV	0.2014	0.1285	1.5667	0.1204		
	C	0.0702	0.0126	5.5407	0.0000		
	P_t	-0.1100	0.0311	-3.5351	0.0006		
11%	$D_t(P_t-\pi)$	-0.0181	0.0099	-1.8225	0.0714	0.1374	0.1110
	INV	0.2149	0.1276	1.6833	0.0955		
	C	0.0746	0.0121	6.1572	0.0000		
	P_t	-0.1106	0.0311	-3.5549	0.0006		
12%	$D_t(P_t-\pi)$	-0.0179	0.0096	-1.8530	0.0669	0.1384	0.1121
	INV	0.2124	0.1276	1.6639	0.0993		
	C	0.0738	0.0118	6.2279	0.0000		
	P_t	-0.1131	0.0306	-3.6873	0.0004		
13%	$D_t(P_t-\pi)$	-0.0236	0.0093	-2.5419	0.0126	0.1658	0.1402*
	INV	0.1735	0.1258	1.3792	0.1709		
	C	0.0786	0.0121	6.4655	0.0000		
	P_t	-0.1162	0.0308	-3.7652	0.0003		
14%	$D_t(P_t-\pi)$	-0.0234	0.0092	-2.5273	0.0131	0.1626	0.1370
	INV	0.1858	0.1262	1.4720	0.1442		
	C	0.0773	0.0118	6.5243	0.0000		
	P_t	-0.1143	0.0309	-3.6952	0.0004		
15%	$D_t(P_t-\pi)$	-0.0219	0.0093	-2.3315	0.0218	0.1563	0.1305
	INV	0.1808	0.1268	1.4259	0.1571		
	C	0.0751	0.0117	6.4093	0.0000		
	P_t	-0.1136	0.0310	-3.6586	0.0004		
16%	$D_t(P_t-\pi)$	-0.0203	0.0095	-2.1410	0.0348	0.1497	0.1237
	INV	0.1804	0.1273	1.4170	0.1596		
	C	0.0737	0.0116	6.3110	0.0000		
	P_t	-0.1115	0.0307	-3.6273	0.0005		
17%	$D_t(P_t-\pi)$	-0.0234	0.0095	-2.4532	0.0159	0.1590	0.1333

Openness was proxied by a ratio of total trade to nominal GDP while financial deepening was represented by the ratio of broad money (M2) to nominal GDP.

All the three variables came out statistically insignificant[3]. Furthermore, their inclusion does not significantly change the results. Infact, the threshold level remains the same.

4.3.3 Sensitivity to Data Frequency

To analyze how changes in data frequency may affect the location and magnitude of the threshold level and parameter estimates, equation 1 was also estimated using quarterly data from 1990 to 2009. Table 3 gives the threshold estimate and parameter estimates of equation 1. The results indicated that, there were no changes in the inflation threshold level over different periods, as the threshold level remained at 13 per cent. However, the coefficient of the inflation dummy was more powerful for the lower frequency data and their significance level was higher when compared to the main regression results.

4.3.4 Sensitivity to High Inflation Observations

Bruno and Easterly (1998) and Easterly (1996) have argued that the inverse relationship between inflation and economic growth holds only for high-inflationary economies. They added that excluding observations with annual inflation rates of 40 per cent or more weakens the negative relationship between inflation and growth. To test the hypothesis within this study, equation 1 was re-estimated with data covering the original period excluding observations with inflation rates higher than 40 per cent. The results are presented in Table 4. It indicated a threshold level of 9 per cent. In addition, the coefficient of the inflation dummy below the threshold level turned out to be positive, while the coefficient of inflation were negative and all but one of them were significant at 5 per cent levels. Consequently, the magnitude of the relationship between inflation and output growth was being affected by high inflation observations.

4.4 Policy Recommendations

The study estimated a threshold inflation level of 13 per cent for Nigeria, implying that below this level, inflation has mild effect on economic activities; while above it, the magnitude of the negative effect of inflation on growth was high.

[3] This results were not included in the study, but were available on request

Table 3: Estimation of Inflation Threshold Model at $\pi = 5$ to $\pi = 17$, Dependent Variable: Y_t (1990:Q1 – 2009:Q4), Sensitivity to Changes in Data Frequency

π	Variable	Coefficient	Std. Error	t-statistics	Probability	R^2	Adj. R^2
	P_t	-0.1000	0.0325	-3.0783	0.0029		
5%	$D_t(P_t-\pi)$	-0.0181	0.0195	-0.9264	0.3572	0.1563	0.1230
	INV	0.1468	0.0783	1.8739	0.0648		
	C	0.0847	0.0211	4.0005	0.0001		
	P_t	-0.0975	0.0325	-3.0014	0.0036		
6%	$D_t(P_t-\pi)$	-0.0109	0.0169	-0.6443	0.5213	0.1514	0.1179
	INV	0.1433	0.0796	1.8000	0.0758		
	C	0.0774	0.0184	4.1940	0.0001		
	P_t	-0.1000	0.0329	-3.0381	0.0033		
7%	$D_t(P_t-\pi)$	-0.0060	0.0133	-0.4558	0.6498	0.1491	0.1155
	INV	0.1531	0.0784	1.9519	0.0546		
	C	0.0726	0.0151	4.8016	0.0000		
	P_t	-0.0994	0.0328	-3.0305	0.0033		
8%	$D_t(P_t-\pi)$	-0.0053	0.0130	-0.4085	0.6840	0.1487	0.1151
	INV	0.1542	0.0785	1.9631	0.0533		
	C	0.0718	0.0146	4.9122	0.0000		
	P_t	-0.0977	0.0327	-2.9892	0.0038		
9%	$D_t(P_t-\pi)$	-0.0000	0.0124	-0.0063	0.9949	0.1468	0.1131
	INV	0.1526	0.0786	1.9421	0.0558		
	C	0.0675	0.0137	4.9036	0.0000		
	P_t	-0.0994	0.0322	-3.0808	0.0029		
10%	$D_t(P_t-\pi)$	-0.0150	0.0119	-1.2640	0.2101	0.1644	0.1314
	INV	0.1557	0.0777	2.0026	0.0488		
	C	0.0782	0.0130	5.9889	0.0000		
	P_t	-0.1007	0.0317	-3.1723	0.0022		
11%	$D_t(P_t-\pi)$	-0.0234	0.0114	-2.0522	0.0436	0.1916	0.1597
	INV	0.1641	0.0766	2.1410	0.0355		
	C	0.0829	0.0123	6.7276	0.0000		
	P_t	-0.1004	0.0318	-3.1577	0.0023		
12%	$D_t(P_t-\pi)$	-0.0217	0.0110	-1.9755	0.0518	0.1885	0.1564
	INV	0.1627	0.0767	2.1196	0.0373		
	C	0.0805	0.0117	6.8262	0.0000		
	P_t	-0.0995	0.0310	-3.2056	0.0020		
13%	$D_t(P_t-\pi)$	-0.0294	0.0105	-2.7811	0.0068	0.2256	0.1950*
	INV	0.1383	0.0750	1.8440	0.0691		
	C	0.0844	0.0113	7.4556	0.0000		
	P_t	-0.1005	0.0311	-3.2305	0.0018		
14%	$D_t(P_t-\pi)$	-0.0287	0.0105	-2.7244	0.0080	0.2227	0.1920
	INV	0.1492	0.0749	1.9897	0.0502		
	C	0.0822	0.0109	7.4832	0.0000		
	P_t	-0.0980	0.0310	-3.1568	0.0023		
15%	$D_t(P_t-\pi)$	-0.0295	0.0106	-2.7738	0.0070	0.2252	0.1947
	INV	0.1484	0.0748	1.9826	0.0510		
	C	0.0802	0.0106	7.5722	0.0000		
	P_t	-0.0974	0.0313	-3.1110	0.0026		
16%	$D_t(P_t-\pi)$	-0.0273	0.0108	-2.5142	0.0140	0.2123	0.1812
	INV	0.1479	0.0755	1.9591	0.0538		
	C	0.0782	0.0105	7.4281	0.0000		
	P_t	-0.0919	0.0310	-2.9602	0.0041		
17%	$D_t(P_t-\pi)$	-0.0312	0.0110	-2.8300	0.0060	0.2241	0.1941

Table 4: Estimation of Inflation Threshold Model at $\pi = 5$ to $\pi = 17$, Dependent Variable: Y_t (1981:Q1 – 2009:Q4), Excluding Observations with Inflation Greater Than 40 Per Cent

π	Variable	Coefficient	Std. Error	t-statistics	Probability	R^2	Adj. R^2
	P_t	-0.1442	0.0657	-2.1943	0.0320		
5%	$D_t(P_t-\pi)$	-0.0014	0.0186	-0.0799	0.9366	0.1136	0.0700
	INV	0.1770	0.0892	1.9840	0.0518		
	C	0.0763	0.0216	3.5234	0.0008		
	P_t	-0.1416	0.0646	-2.1911	0.0323		
6%	$D_t(P_t-\pi)$	0.0028	0.0167	0.1696	0.8659	0.1139	0.0703
	INV	0.1795	0.0902	1.9909	0.0510		
	C	0.0722	0.0194	3.7108	0.0004		
	P_t	-0.1346	0.0653	-2.0610	0.0436		
7%	$D_t(P_t-\pi)$	0.0090	0.0146	0.5399	0.6164	0.1190	0.0757
	INV	0.1804	0.0890	2.0268	0.0471		
	C	0.0670	0.0174	3.8510	0.0003		
	P_t	-0.1346	0.0651	-2.0664	0.0430		
8%	$D_t(P_t-\pi)$	0.0093	0.0144	0.6505	0.5178	0.1196	0.0763
	INV	0.1784	0.0888	2.0076	0.0491		
	C	0.0670	0.0168	3.9721	0.0002		
	P_t	-0.1260	0.0642	-1.9608	0.0545		
9%	$D_t(P_t-\pi)$	0.0188	0.0136	1.3848	0.1711	0.1405	0.0983*
	INV	0.1819	0.0878	2.0702	0.0427		
	C	0.0602	0.0158	3.8077	0.0003		
	P_t	-0.1396	0.0641	-2.1765	0.0334		
10%	$D_t(P_t-\pi)$	0.0079	0.0132	0.6013	0.5499	0.1187	0.0754
	INV	0.1798	0.0890	2.0205	0.0477		
	C	0.0695	0.0148	4.6878	0.0000		
	P_t	-0.1433	0.0641	-2.2343	0.0291		
11%	$D_t(P_t-\pi)$	-0.0012	0.0131	-0.0917	0.9272	0.1136	0.0700
	INV	0.1770	0.0892	1.9848	0.0517		
	C	0.0755	0.0143	5.2810	0.0000		
	P_t	-0.1430	0.0640	-2.2316	0.0293		
12%	$D_t(P_t-\pi)$	0.0006	0.0130	0.0467	0.9629	0.1135	0.0699
	INV	0.1774	0.0892	1.9878	0.0513		
	C	0.0745	0.0137	5.4278	0.0000		
	P_t	-0.1442	0.0637	-2.2632	0.0272		
13%	$D_t(P_t-\pi)$	-0.0112	0.0134	-0.8328	0.4082	0.1235	0.0804
	INV	0.1614	0.0906	1.7805	0.0800		
	C	0.0805	0.0137	5.8760	0.0000		
	P_t	-0.1466	0.0640	-2.2899	0.0255		
14%	$D_t(P_t-\pi)$	-0.0094	0.0138	-0.6844	0.4963	0.1203	0.0770
	INV	0.1677	0.0899	1.8661	0.0668		
	C	0.0792	0.0135	5.8602	0.0000		
	P_t	-0.1436	0.0641	-2.2403	0.0287		
15%	$D_t(P_t-\pi)$	-0.0033	0.0149	-0.2220	0.8250	0.1142	0.0707
	INV	0.1731	0.0910	1.9022	0.0619		
	C	0.0760	0.0131	5.7855	0.0000		
	P_t	-0.1429	0.0640	-2.2306	0.0294		
16%	$D_t(P_t-\pi)$	-0.0011	0.0155	-0.0723	0.9426	0.1136	0.0700
	INV	0.1758	0.0912	1.9281	0.0585		
	C	0.0752	0.0128	5.8626	0.0000		
	P_t	-0.1417	0.0641	-2.2080	0.0310		
17%	$D_t(P_t-\pi)$	-0.0048	0.0164	-0.2941	0.7697	0.1148	0.0712

The findings have some policy implications, thus:

a. The findings are essential guide for monetary policy management in Nigeria. It confirms the appropriateness of the single digit inflation rate being

currently pursued, which is believed to engender long-run sustainable economic growth. It provides a guide for the policy makers to choose an optimal target for inflation, which is consistent with long-term sustainable economic growth goals of the country.

b. In the short to medium term, monetary policy makers and other stakeholders should harness all pointers of inflation movements and or expectations in order to ensure relative stability of general price changes due to seasonality and business cycles. The use of the outcome of expectations surveys could make a big difference in tracking of inflation movements in the short-run.

5.0 Summary and Conclusion

Governments and central banks worldwide might want to achieve price stability for several reasons, with the most compelling being the potential for long-term growth. This was so as the overall weight of empirical evidence so far clearly indicated that high inflation was inimical to output growth. Utilizing quarterly data for the period 1981 – 2009, this study attempted to estimate the threshold level of inflation for Nigeria, beyond which inflation exert a negative impact on economic growth. Using a threshold regression methodology developed by Khan and Senhadji (2001), the study found a threshold inflation level of 13 per cent for Nigeria. Below the threshold level, inflation has a lower negative effect on output growth. Above it, the magnitude of the negative effect of inflation on growth was higher. The study also found that there was a negative and significant relationship between inflation and growth in Nigeria for inflation rates both below and above the threshold level. The threshold level regression was found to be robust with respect to changes in econometric methodology, additional explanatory variables and changes in data frequency. It was, however, very sensitive to the exclusion of high inflation observations, thus, validating the Bruno and Easterly hypothesis. This result is consistent with the findings of Khan and Senhadji (2001) that estimated a threshold level of 11 – 12 per cent for developing economies, and Frimpong and Oteng-Abayie (2010) that indicated a threshold level of 11 per cent for neighboring Ghana. These findings are essential for monetary policy formulation by the Central Bank of Nigeria, whose primary objective is the achievement and maintenance of price stability, as it provides a guide for the Bank to choose an optimal inflation rate, which is consistent with long-term sustainable economic growth goals of the country.

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