



# The Relationship between Inflation and Economic Growth in Nigeria: A Conceptual Approach

Miftahu Idris<sup>1\*</sup> and Rosni Bakar<sup>1</sup>

<sup>1</sup>School of Business Innovation and Technopreneurship, Universiti Malaysia Perlis, Malaysia.

## Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

## Article Information

DOI: 10.9734/ARJASS/2017/33365

### Editor(s):

(1) Jan-Erik Lane, Institute of Public Policy, Serbia.

### Reviewers:

(1) Vadasan Ioana, West University of Timisoara, Romania.

(2) Damian Kalu Ude, Michael Okpara University of Agriculture, Nigeria.

(3) Manamba Epaphra, Institute of Accountancy Arusha, Tanzania.

Complete Peer review History: <http://www.sciencedomain.org/review-history/19059>

Review Article

Received 11<sup>th</sup> April 2017  
Accepted 10<sup>th</sup> May 2017  
Published 15<sup>th</sup> May 2017

## ABSTRACT

The rate of inflation over the last three decades in Nigeria has significantly increased thereby affecting the macroeconomic growth and international competitive drive of the growing economy. The magnitude of this inflationary trends may be largely explained by the rapid growth of money supply motivated by the expansionary fiscal policies of the public sector, in addition to exchange rate fluctuation and poor diversification of the economy. After numerous attempt by successive administrations to regulate this economic problem using both monetary and fiscal policies, efforts seems to be abysmal. As a result, this paper is designed to explore the inflationary trend in Nigeria with the view to determining its impact on economic growth. The study adopted a descriptive method and further utilised charts to show the inflationary trend and GDP growth in order to provide better understanding on how inflation rates in Nigeria affects the desired level of economic growth. This is necessary because identifying the possible relationship between inflation and economic growth may expedite the process of realising the feasible policy options to be adopted towards achieving sound macroeconomic growth in Nigeria. This study therefore concludes that the current inflationary trend in Nigeria is negatively affecting the realisation of sustainable growth and development. This implies that one of the necessary requirements for attaining the desired growth level in Nigeria is to control the excessive increase in inflation rate. As a recommendation, there is need for the public sector to design a suitable framework that will encourage local

\*Corresponding author: Email: [miftahu4real12@gmail.com](mailto:miftahu4real12@gmail.com);

producers to engage in innovative economic activities. This will create a platform for creativity and manufacturing of commodities with international competitive advantage. The multiplier effects of this approach will undoubtedly increase the export volume of the growing economy, raise productivity level and competitive drives, reduce the exchange rate fluctuation, increase employment creations, raise income growth and economic welfare, and largely the fiscal prudence and macroeconomic growth.

*Keywords: Inflation; economic growth; positive effect; negative effect.*

## **1. INTRODUCTION**

The primary aim of every country, irrespective of its level of economic development, is to ensure a relative price stability through a well-disciplined inflation rate. Sound and productive level of inflation is certainly regarded as a repercussion of fiscal prudence and essential criteria for the attainment of a sustainable level of growth and development. Inflation rates in the last three decades have established an accelerated trend which engendered enormous uncertainty in the macroeconomic management of Nigeria, including a decrease in societal welfare and economic efficiency. This is largely due to the general decline in oil price in the 1980s resulting to lower revenue mobilisation. The public sector during this period had to borrow to allow for the execution of government capital and recurrent programmes. However, private investors are discouraged from participating in economic activities when the resultant inflation level is high, and this circumstance grossly undermined the prospect of output growth in an economy [1]. Suffice to mention the reasons why local manufacturers in Nigeria shriek of high operation cost, by so doing, making the foreign commodities to account for more competitive advantage over the locally-manufactured goods in terms of cost of operations and product quality. Persistent increase in inflation rates reliably discourages saving and investment, and thus, hinders productivity and output level. It may also decrease the international competitive drive of an economy, thereby causing the country's export to be relatively expensive and further creating a negative effect on the balance of payments. In addition, inflation and tax system can network together to hamper borrowing and other credit decisions. A higher rate of inflation is largely detrimental to economic growth because it simultaneously increases the cost of borrowing and lowers the rate of capital investment. It is therefore used as an indicator to determine the level of macroeconomic instability in a given economy [2]. It can therefore be deduced that a persistent and gradual increase in the general

price level of goods and services is regarded as inflation.

The relationship between inflation and economic growth remains a controversial issue in macroeconomic theory and a deliberated subject among the policy makers. The argument originated from the Latin American context in the 1950s, hence, has further engendered a long-term debate between the structuralists and the monetarists [3]. The structuralists argued that inflation is important for economic growth, whereas the monetarists hold the view that inflation has a retarding effect on output growth. Basically, the rate at which economic growth manifest depends primarily on the level of capital formation; and the degree of capital formation is a function of savings and investment rate. Therefore, whether inflation affects real output growth is a function of whether it affects the level of savings and investment both in the short and long-run, respectively [4,5]. In the literature, there exists an enormous volume of studies relating to the nexus of inflation and economic growth, but with diverse and conflicting results. This is attributed to different macroeconomic conditions of the individual countries, different dataset and years of investigation, and also different techniques of analysis and model specifications. Furthermore, most of the previous literature utilised the non-recent dataset to conduct their analysis even when the period of such studies are relatively short. In addition, more emphasis were given in determining the threshold level of inflation using a comparative analysis. However, this paper will provide a clear departure from the literature by employing a recent dataset for more than 3 decades using the 2010 base year. Every country has its own peculiar characteristics, hence, the study will concentrate largely on the Nigerian economy with the view to providing meaningful information about the appropriate level of inflation through exploring the inflation trend. This is particularly essential not only to the policy makers but by extension to the private investors. In view of this background, the objective of this paper is to explore the

inflationary trend in Nigeria with the aim of determining its impact on economic growth. The study adopted a descriptive method to provide better understanding on how inflation in Nigeria affected the desired level of economic growth. Charts are also utilised in the study to show both the inflationary trend and GDP growth, hence providing more insight on inflation-growth nexus. By this, adequate knowledge on the functioning of the Nigerian economy is obtained, while the outcome will serve as a working tool for policy makers and private investors in the decision making process.

Regardless of that, low inflation rates are desirable for the sustainability of output growth, while high and fluctuating rates of inflation has proven to be growth-retarding and inversely related to sustainable development. Nevertheless, an insignificant agreement exists in the literature on the exact link between inflation and output growth, and the determining factors of inflation which may affect the productivity level. Until recently, macroeconomist has adopted an econometrics technique which establishes that the effect of inflation on real output growth could be positive up to a certain threshold level, and beyond which, the effect turns to be negative [6]. This, however, supports the argument of both the structuralists and the monetarists to a greater magnitude, meaning that, lower inflation rate is essential to output growth but once the economy attains a higher level of growth, then, high inflation becomes harmful for the sustainability of such output growth [7]. In other words, no any school of thought in the literature that shows support for accelerating level of inflation, as it has demonstrated to be detrimental to economic welfare and fiscal prudence. As a result, several factors are considered as a determining forces for inflation including increased wage rate aggravated by labour unions, rapid money supply into the domestic economy, increased liberalisation and openness of the economy, and exchange rate devaluation. Thus, the corrective measures of this economic menace may likely possess the policy mix of both fiscal and monetary mechanisms.

It can be deduced that, depending on the causes of inflation and the general macroeconomic conditions in a particular country, inflation can produce diverse effects on real output growth. Moreover, in order to identify and understand the nature of the link between inflation and real output growth rate, it is essential to determine the

sources of inflation and the circumstances surrounding output growth in the respective country [8,9], which will succour to develop and implement an effective economic policy that would lead to an eventual transformation of the economy. Although, examining the inflation-economic growth nexus is necessary, it is not a sufficient condition for the development of an effective economic policy [3,9]. It is in view of this that, this study examined critically the relationship between inflation and output growth in Nigeria with the aimed of identifying macroeconomic implications of the high and unstable increase in prices on the domestic economy. The paper is further sub-divided into four sections, namely; section 2 contained the empirical review of the literature based on three different schools of thought including those who argued for the positive relationship, for negative relationship, and finally, for a neutral or unbiased relationship. Section 3 critically provides an overview of inflationary trends in Nigeria covering more than three decades from 1980 to 2015 with the view to identify its macroeconomic implications on output growth in Nigeria; section 4 evaluates and highlighted a number of challenges posed by the excessive inflation rate in Nigeria including its effects on economic efficiency and fiscal prudence; and finally, section 5 provides the concluding remarks and policy implications towards realising a moderate or productive level of inflation with the view to ensure a sustainable and long-term growth.

## **2. EMPIRICAL REVIEW OF THE LITERATURE**

In the macroeconomic literature, the relationship between inflation and its effects on attaining the desired level of sustainable growth and development has engrossed the attention of several professionals over a number of decades. The two most prominent school of thoughts with divergent views on this research domain are the structuralist and monetarist. The structuralist are of the opinion that inflation is not a counter-productive in the attainment of economic growth, while the monetarist debated that inflation is growth-retarding in realising any meaningful growth and sustainable development. Other scholarly contributions established no any relationship between the subject matter, as they remain neutral and unbiased. In view of this, this study identifies numerous views from the literature as postulated by different scholars with the view to identify the dominant perspectives and established a stable relationship between

the two different macroeconomic indicators. Therefore, the following studies and scholarly contributions are identified from the literature and reviewed as follows:

## **2.1 Structuralist View**

In support of the structuralist argument, [8] examine the link between growth and inflation in Turkey for the period 2004-2013 using a quarterly data. The study makes use of an OLS estimation technique, granger causality and Johansen cointegration tests to identify the possible relationship that may exist among the stationary variables. Empirical support shows that only one cointegration vector is identified implying a long-term relationship among the variables, and a unidirectional causality running from CPI to GDP. The study concludes that inflation has a positive, though not significant effect on output growth.

Similarly, [10] analyse the effect of inflation, interest rate and exchange rate on GDP in Indonesia by applying an OLS estimation technique. Findings reveal that the effects of inflation on GDP generate a path coefficient of insignificant value although positive, this indicates that inflation has a significant influence on GDP over the period. In addition, [11] investigates the threshold effect of inflation on economic growth in a balanced panel of 40 developing countries spanning 1960-2004 using a generalised panel threshold model by allowing for regime intercepts. Results showed that a low inflation rate, specifically less than twelve percent (12%) is associated with a significant positive effect on growth.

In another development, [12] investigates the link between a consumer price index and economic growth in Mauritania with time series data covering the period 1990 – 2013. Using an OLS technique and granger causality test, empirical outcome obtained from the estimation reveals a positive and significant relationship between CPI and output growth. In addition, the granger causality test reveals a unidirectional causality, showing only CPI Grange causes GDP without any feedback. Moreover, fifty-six percent (56%) of the total variation in GDP is explained by the CPI in the model. This means that any changes in the price level will automatically cause fluctuation in output growth within the review period.

Likewise, [3] assess the effect of inflation on the growth and development of the Nigerian

economy for the period 1970-2010 using OLS and granger causality techniques for the estimation. Results showed that one percent (1%) increase in inflation raises the economic growth (GDP) by 51 percent. This implies that inflation is statistically significant and has a positive effect on output through encouraging productivity and output level, though GDP growth does not solely depend on inflation, but on other factors which may inhibit output growth in an economy. An outstanding performance of an economy in terms of per capita growth may, therefore, be attributed to the rate of inflation in the country. Nevertheless, the result of granger causality reveals a unidirectional causal link running from GDP to inflation without any feedback. Meaning that, inflation does not granger causes GDP, rather, it is GDP that granger causes inflation.

Furthermore, [13] examine the link between growth and inflation in Nepal spanning 1975 to 2010 using OLS estimation technique and granger causality test. The study reveals a positive relationship between inflation and economic growth. The causal link indicates a unidirectional relationship, running from inflation to economic growth, but not from economic growth to inflation. While the threshold value of inflation is found to be six percent (6%) for Nepal. Beyond that level, (higher or lower than the threshold value) the economic growth can be endangered and vulnerable. Likewise, [14] examine the causal relationship between inflation and economic growth in Pakistan and empirically determine the threshold level of inflation from 1973 to 2000. An assessment of the empirical evidence has been acquired through OLS estimation technique and Granger Causality test. Results showed a unidirectional causality running from inflation to economic growth without any feedback. Meaning that inflation granger causes output growth, but the output does not cause inflation. The study concludes that the threshold model supports nine percent (9%) level of inflation at which inflation is at peak for sustainable economic growth, but any estimated value below 9% is conducive for economic growth.

In a similar analysis, [15] assess the effect of inflation on economic growth as well as determine the threshold level of inflation in Nigeria using quarterly time series data for the period 1981 to 2009. Two-Stage Least Square (2SLS) and threshold regression model are employed, and the study found that a threshold

inflation level of 13 percent (13%) for the Nigerian economy is satisfactory. In addition, there exist a negative and significant relationship between inflation and growth for inflation rates below and above the threshold level, respectively. Likewise, [1] examine the relationship between the inflation and the economic growth in Turkey using a quarterly time series data of GDP and Consumer Price Index for the period of 1987:1 to 2006:2. The data are collected from Electronic Data Distribution System in CBRT's. An ARDL model as developed by [16] and Toda Yamamoto causality analysis approach are utilised as the techniques of analysis. Results shows the existence of a cointegration relationship between economic growth and inflation. In the long-run, no significant relationship is established while it is found to be negative in the short-run.

More support is provided by [17] in a study that assesses the relationship between inflation and economic development in India spanning 1942 to 2010 using a conceptual framework. The study identified among other things, that, higher output growth and low inflation are part of the essential objectives of macroeconomic policy. Therefore, lower inflation rate is beneficial for sustainable development while a higher rate of inflation (above a certain level) is detrimental to the desired economic development. In other words, a positive and significant long-run relationship exists between inflation and economic development in Indian economy within the review period.

Similarly, [18] evaluate the causal link between inflation and economic growth in Romania covering the period of 2000 to 2011 by employing VAR technique and Granger Causality test. Findings reveal that a rapid increase in economic growth does not determine an increase in CPI. However, the study shows a positive response of output growth rate to a positive shock in inflation. This shows that inflation rate was mainly determined by demand factors within the review period, with the consumers increasing current consumption in order to avoid future higher prices, while the producers increase the supply in order to maximise the existing profits. In the same vein, [19] evaluate the nature of the relationship between inflation and economic growth in Bangladesh covering the period of 2000 to 2012 by making use of an OLS estimation technique. The result shows a positive relationship between inflation and GDP growth rate, but this was fuelled more by domestic

supply shocks (caused by excess flood, resulting in heavy loss of farm output) and global price hikes. However, the current build-up of inflationary pressure can partly be attributed to the liquidity expansion that took place within the first half of the year 2012.

In another development, [20] evaluates the relationship between CPI and other macroeconomic variables as its determinants covering the period of 1960 to 2012. Time series techniques including Johansen co-integration test, vector error correction model and granger causality test are applied for analysis. Findings reveal that consumer price index is positively related to output growth, exports of goods and services and broad money supply. While a causal relationship exists among the policy variables both in the short and long run, respectively. In addition, [21] examine whether a relationship exists between economic growth and inflation in four (4) South Asian countries (Bangladesh, India, Pakistan and Sri Lanka) covering 1974 to 1997 by applying cointegration and error correction models to empirically examine long-run and short-run dynamics relationship. In addition to significant feedback effect between inflation and economic growth, the study further concludes that inflation and output growth are positively related, and the sensitivity of inflation to changes in growth rates is higher than that of growth to changes in inflation rates.

Moreover, [22] estimates the effects of inflation in West African Monetary Zone (WAMZ), with particular reference to Nigeria and Ghana from 1970 to 2008 by acquiring conditional least square technique and Granger causality test. An assessment of the empirical results from Granger causality test shows no any causal relationship between real output growth and inflation. The result proposes that economic growth and inflation do not have predictive power for each other in both countries during the review period. Further empirical support from conditional least square technique found the existence of a statistically significant and positive relationship between low or moderate inflation and economic growth in the two review countries. In addition, the empirical results strongly suggest the existence of 10% and 13% threshold inflation levels for both Ghana and Nigeria, respectively, beyond which inflation begins to establish negative impacts on economic growth. The study concludes that any inflation rate below or above the optimal

threshold level could be harmful to economic growth.

In addition, [6] debated on the non-linear relationship between inflation and economic growth by applying the Panel Smooth Transition Regression (PSTR) and dynamic GMM models to a broad data set for 102 developed and developing countries over the period of 1960 to 2009. Results confirmed that the relationship between inflation and growth is nonlinear and that there exists a certain threshold above which inflation is harmful and below which it enhances growth. Furthermore, the study found that inflation has a significant influence on output growth, but the extent and direction of the effects are country-specific and depends on a number of factors, namely; the degree of trade openness, level of capital accumulation, the extent of financial development and size of the government, all are found to be the central factors responsible for varying the nonlinearity of inflation–growth relationship over time and across countries.

## **2.2 Monetarist View**

In support of the monetarist view, [4] examines the effect of inflation on growth in the ASEAN-5 countries for the period of 1980-2011. The study applies a Panel Smooth Transition Regression (PSTR) and GMM-IV specification. The outcome from the estimation provides strong evidence that the relationship between inflation and growth is non-linear. Furthermore, the study found that there exist a statistically significant negative relationship between inflation and growth for the inflation rates above the threshold level of 7.84%, which inflation begins to hinder economic growth in the ASEAN-5 countries. Furthermore, [5] adopts a dynamic panel threshold growth regression which allows for fixed effects and endogeneity to examine the nonlinear relationship between inflation and economic growth for 32 Asian countries over the period 1980–2009. Findings from the study reveal the existence of a non-linear relationship between inflation and economic growth. This implies that inflation exerts a negative influence on output growth, especially when above the thresholds level of 5.43% over a long-run period. Furthermore, increased initial income decreases growth, though investment ratio and maintaining a greater level of openness stimulates economic growth.

In addition, [23] investigate the impact of inflation on economic growth in Nigeria over the period of

32 years spanning 1980 to 2011 by utilising OLS multiple regression techniques. The outcome from the estimation shows that inflation and interest rate are inversely related to economic growth within the review period. Furthermore, exchange rate also established a negative relationship with the economic growth in Nigeria. Similarly, [24] explore the nexus between inflation, savings and output in Nigeria using time series data spanning 1970 to 2010 by employing VAR and granger causality techniques for the estimation. Empirical results showed that over 90 percent of the total variation in GDP is captured by the explanatory variables in the model. In addition, findings from individual coefficient reveal that inflation tends to worsen output growth while saving rate essentially enhances economic growth. However, granger causality test concludes that no any cause-effect relationship exists between inflation and output in Nigeria. Apparently, a feedback relationship exists between savings and output in Nigeria. Thus, changes in savings effectively bring about changes in output.

Likewise, [25] empirically investigates the existence of a long-run relationship between money supply, inflation and economic growth in Nigeria as well as identify the possible economic fundamentals that influence the relationship spanning the period of 1975 and 2008. The study utilised error correction mechanism and the bounds testing approach to cointegration within an Autoregressive Distributed Lag (ARDL) technique. The result supports the argument that a negative relationship exists between inflation and output growth, while money supply and economic growth nexus show a positive relationship. In other words, inflation dampens and worsens economic growth within the review period.

In another development, [26] investigate the link between oil price, inflation and economic growth in Jordan for the period 1990-2011 by utilising cointegration, VECM and granger causality test to determine the possible relationship that may exist among the policy variables. The quantitative outcome from the estimation indicates that a long-run equilibrium relationship exists between gross domestic product and inflation. Furthermore, estimates of the VECM support the existence of significant but a negative causal relationship in the short run between GDP and inflation, with the causality running from inflation to GDP. By implication, an increase in the level of inflation will significantly reduce output growth

in the Jordanian economy within the coverage period.

In the same vein, [9] examine the empirical relationship between the dynamics of inflation and economic growth in Kyrgyzstan for the period of 1994 to 2012 using granger causality test and Regression analysis. A negative relationship between inflation and economic growth was revealed from the estimation. This may largely occur due to a predominance of special conditions (over dependence on import) in Kyrgyz economy and monetary causes of inflation in this period. Also, Results from granger causality test indicate the presence of a unidirectional causal relationship between CPI and economic growth. More precisely, the change effect of CPI towards economic growth rate has a one-way causal relationship without any feedback. The study concludes that inflation is the cause, while economic growth is the consequences of the causal effect.

Furthermore, [27] debated on whether inflation affects the long-run growth performance in Indian economy using annual data over the period 1989-2013. In order to estimate the model, the study employed Cross-Sectionally Augmented Distributed Lag (CS-DL) approach and the standard panel ARDL methodology. Results showed that inflation has a significant negative effect on economic growth, especially when above the threshold level of 5.5 percent. In other words, high and persistent inflation, no matter how it is created, produce an essential weakness to output growth rate in an economy. Likewise, [7] examine the relationship between inflation and economic growth in Bangladesh covering 1981 to 2005. Econometrics estimations namely; Engel-Granger technique and Error Correction Model (ECM) are adopted for the analysis. Empirical evidence demonstrates that there exists a statistically significant long-run negative relationship between the consumer price index and real GDP growth. In addition, the projected threshold coefficient reveals an average of six percent (6%) level of inflation, above which inflation may adversely affect economic growth.

Moreover, [28] study the link between inflation and economic growth in Kuwait using an annual dataset on real GDP and CPI for the period of 1985 to 2005 by applying Engel-Granger cointegration technique and Error Correction Model (ECM). The estimated result reveals an existence of a long-run and strong inverse relationship between CPI and real GDP in Kuwait

which in turn implies a long-run negative relationship between inflation and economic growth for the country. This implies that short run changes in CPI negatively affect real GDP in Kuwait. More empirical support is provided by [29] in a study that empirically investigates the significant relationship between inflation, output growth, volatility and causality using a panel data of G-7 countries spanning 1960 to 2000. Assessment of empirical evidence has been acquired through Error Correction VAR (ECVAR), panel causal effect and GARCH model. The results showed that inflation has an influence and negatively affects output growth, while the error correction coefficients are also negative and statistically significant, indicating that inflation does cause economic growth and vice versa. In other words, there are feedback effects between inflation and economic growth.

In addition, [30] investigates the possible relationship between inflation and output growth in the Nigerian economy covering a ten-year period; 2002 to 2012. The study adopts OLS estimation technique and found that a negative and significant influence of inflation exists on economic growth. This implies that CPI and GDP have an inverse relationship; hence a lower CPI will lead to an increase in GDP and vice versa. Similarly, [31] examine the relationship between inflation and economic growth in Fiji using correlation matrix and granger causality test over a period of 34 years; 1970 to 2003. Quantitative support from correlation coefficients shows a negative relationship between inflation and output growth, while causality runs from economic growth to inflation. In other words, the results suggest a unidirectional causality, with the causal link running from growth to inflation. This negative link is consistent with the outcomes of traditional Keynesian theory, Stockman's neoclassical model and some endogenous growth theories, which hold the views that high level of inflation rate is negatively associated with economic growth.

Equally, [32] empirically investigate the nexus between inflation and economic growth in Malaysia using an annual time series data, covering 1971 to 2007. Standard econometrics tool; VECM and VAR methodologies are applied in order to examine the possible effects that may exist among the policy variables. Estimated finding shows that there exist a long-run relationship between inflation and economic growth in the economy of Malaysia, but the intensity of the linkage is revealed by VECM.

That is, in the short run, inflation has an essential role in negatively influencing economic growth, while in the long run, it affects output growth positively. In addition, the response of economic growth due to the impulse of inflation is insignificant; whereas the response of inflation due to shocks in economic growth is effective. This supports the VAR findings that output growth granger causes inflation without feedback effect.

Also, [33] empirically examines the relationship between inflation and output growth in Japan using quarterly data from 1957:Q4 to 2002:Q3. The study employed Maximum Likelihood Estimation (MLE) to evaluate the bivariate EGARCH-M model, while Engel-Granger and Johansen cointegration tests are both utilised to determine the possible relationship that may exist among the variables in the study. The study found a strong evidence for the prediction that increased output growth raises average inflation. In addition, unidirectional causality exists from output growth to inflation in Japan, though, no evidence of cointegration found among the variables. The coefficients in the conditional variance equations for inflation and growth, respectively, are both negative and statistically significant. Likewise, the constant correlation coefficient in the conditional covariance equation is statistically insignificant.

Additionally, [34] investigates the causal link between inflation, money supply and economic growth in Ethiopia spanning the period of 1970 to 2011 by applying the tri-variate Granger-Causality test, VECM and Johansen cointegration technique. An empirical outcome shows the existence of an equilibrium relationship and a bi-directional causality between inflation and money supply in the long-run, and a unidirectional causality in the short run, respectively. Furthermore, the link between output growth and inflation is unidirectional particularly in the long-run, with the causality running from growth to inflation without feedback effect. In other words, output growth has a negative effect on inflation. The study concludes that, if the fundamental sources of output growth are noninflationary such as an increase in productivity, then, economic growth reduces inflation. Whereas, if GDP growth emanates from an increase in money supply above the real output, then, inflation takes place. Likewise, [35] assess the non-linear relationship between inflation and economic growth in Mexico based on panel data model econometric estimates of

constant, fixed and random effects, covering the period of 2000 to 2013. The study found a negative and significant relationship between the two variables, indicating the negative influence of inflation on output growth in the model.

Furthermore, [36] debated on the level at which inflation will be harmful to the Ghanaian economy by applying a threshold regression model to estimate the threshold level of inflation spanning the period of 1960 to 2008. The study found a negative and significant relationship between inflation and economic growth, while, 11% threshold level of inflation is revealed, beyond which, it retards economic growth. The coefficient is statistically significant at 5%, meaning that, if inflation increases beyond the 11% threshold level, economic growth would approximately change by the sum of the coefficients. In other words, if inflation increases above the 11% threshold, economic growth is expected to decline by about 0.02%. The study concludes that inflation should be maintained below the threshold level to avoid adverse effects on output growth.

Similarly, [37] examine the causal relationship between inflation and output growth rates and also determine the threshold level of inflation in South Africa. In addition to granger causality test, the study adopts a threshold regression analysis and two-stage least squares instrumental variable (2SLS-IV) to check for robustness on quarterly time series data over 1980:Q2 to 2010:Q3 period. Results from granger causality test establish that inflation does Granger cause economic growth at different levels of significance. This implies that a unidirectional causality exists from inflation to economic growth without any feedback effect. Whereas, an estimated 4% threshold level of inflation was revealed for sustainable output growth, above which, it may be detrimental to GDP growth. In addition, further results obtained indicate the existence of a strong negative relationship between economic growth and inflation rates, but this appeared more significant at an inflation rate above the threshold level.

In addition, [38] investigate the impact of inflation on economic growth in Tanzania by employing a reduced-form regression equation, the coefficient of elasticity and co-integration technique to measure the possible relationship that may exist among the two policy variables. Annual time-series data covering a period of 1990-2011 are used, and the regression result shows that inflation has a negative effect on economic



growth of Tanzania. This means that inflation is significantly destructive to output growth. Furthermore, Johansen cointegration test establishes no cointegrating relationship between the study variables, that is, long-run relationship between inflation and output growth does not exist within the review period. Moreover, the degree of responsiveness of GDP to change in the inflation was found to be inelastic.

In another similar analysis, [39] examines the relationship between inflation and economic growth in Tanzania and further determine the nonlinearity of the inflation-growth nexus using annual time series data covering the period of 1967 to 2015 using a quadratic regression model which is estimated as a second-degree polynomial. Variables adopted in the study includes investment, the rate of population growth, and the degree of openness. A linear and non-linear regression model are derived from the endogenous growth model and used as the method of analysis, while Johansen cointegration is employed to examine the existence of the relationship among the variables. While there is an existence of a stable long-run relationship between the series, the concluded result shows a negative relationship between inflation and growth in Tanzania.

Likewise, [40] argued on the relationship between inflation and economic growth and ascertain a significant threshold impact of inflation on output growth in Ghana spanning the period of 1955 to 2009. The study employed Granger causality test, correlation coefficients and threshold regression model for the analysis. The result shown indicates evidence of a significant threshold effect of inflation on output growth either with or without a structural break. Simultaneously, the evidence shows a minimum and maximum inflation threshold level of 6% and 10% respectively. In addition, inability to account for a structural break in the model significantly biased the estimated effect of threshold inflation level on economic growth. Also, the correlation coefficients calculated for each illustration are negative and statistically significant given the t-statistics, while economic growth granger causes inflation and not the other way round. In other words, a unidirectional causality exists, with the causal relationship running from real output growth to inflation.

### **2.3 Neutral and Unbiased Views**

In this section, the paper identifies different literature that remains unbiased and established

a balanced relationship between inflation and economic growth. Among these include, but not limited to the following articles: [41] examines the relationship between inflation and economic growth in Nigeria using Johansen cointegration technique and granger causality test. The estimated results could not find any long-run relationship between inflation and economic growth. This, therefore, supports the argument that no cointegrating relationship among the two policy variables. Though, causality runs from inflation to economic growth, indicating an influence of inflation on output growth. The study remains neutral as it does not conclude on whether the link is positive or negative. Similarly, [42] examines the causal relationship between money growth, Inflation, currency devaluation and economic growth in Indonesia using annual data for the period 1954-2002. In order to achieve this objective, a trivariate Granger-Causality test was adopted, and finding shows that the relationship between inflation and economic growth established no short-run causality among the two variables, particularly from inflation to output growth for the entire review period. In addition, the empirical results support the existence of a short run bi-directional causality between money growth and inflation and between currency devaluation and inflation, respectively.

In conclusion, a review of the aforementioned literature indicates a prevalence of significant differences among the results of empirical literature, as the effects of inflation on real output growths are relatively different across regions of the globe. Such discrepancies in findings are more pronounced given the techniques of analysis, model framework and specifications, types of data used, and the process of estimating the threshold level of inflation for individual countries. These studies generally found that for countries with initial low-inflation rate, a modest increase in the inflation level does not affect long-run output growth [11,12]. But for countries with an initial high inflation rate, any supplementary increase may establish an adverse negative effect on real economic growth [23,25,27].

### **3. AN OVERVIEW OF INFLATIONARY TREND AND ECONOMIC GROWTH IN NIGERIA**

The Central Bank of Nigeria has the responsibility of monetary management including inflation control. After numerous attempts by the

apex bank to ensure a single digit inflation rate, the efforts prove to be abortive particularly during the military regimes and the post-era of Structural Adjustment Programme (SAP). During the oil boom era of the 1970s, the military administrators designed several inflationary policies that lacked accountability and transparency which further resulted in large scale diversion of public funds to private use, thus, engendered fiscal imbalances. The overall outcome of these negative circumstances over the years was the accelerated and continuous increase in the rate of inflation. The inflation rate averaged 9.9% in 1980, peaking to an average of 39.6% in 1984 (Just two years after) while dropping to 13.7 percent in the period of 1986 (see Fig. 1). These are undoubtedly related to the questionable government policies of military leadership that have utterly undermined the conditions of realising a fiscal prudence. However, despite the tight fiscal and monetary measures adopted in 1980's during the Economic Austerity and SAP reforms, the situation became more alarming and terrifying with the inflation rate establishing the uttermost points in 1988, 1993 and in 1994, destructively to about 61.2%, 61.3% and 76.8% respectively to become the highest uncommon levels ever attained in the history of the Nigerian economy, in spite of the relatively low rate of government expenditure to GDP ratio, the growth rate of money supply, and output growth rates, respectively (see Fig. 2). In the period of 1993, the GDP growth rate was found to be 1.57% but later decrease to a marginal 0.26% in 1994. During the entire SAP period 1986-1994, the Nigerian economy experienced a fluctuating performance. The GDP growth rate appeared very dismal and negative in some cases (for instance, 1991) while inflation rate maintained an upwards increase. This may partly be the result of poor complementary policies adopted under the SAP programme, the deterioration in the terms of trade around 1980's, the decline in the price of crude oil in the international oil market leading to the decline in the volume to export, the fluctuating exchange rate, and also the increase in the importation of consumable goods due to lower output from the domestic agricultural sector. As a result, the entire macroeconomic environment appeared destabilised and further grossly undermined other efforts by the public sector to entrench sound macroeconomic stability. This increased trend continues up to 1999 where inflation recorded a lower value of 6.6%, thus, considered desirable for any meaningful development.

Despite the enormous advantages and much-celebrated benefits of returning to a democratic system of leadership in 1999, the rate of inflation during the period seems to be challenging; causing other macroeconomic indicators to a general state of disequilibrium, including a lower a value of 0.52% for GDP growth rate. The growth of money supply also seems to contribute to the unstable nature of inflation due to election campaign leading to a rapid increase in money supply. In the year 2000, inflation raises to a double-digit of 14.5% which is higher than what is obtainable in the previous year. This is largely attributed to the increased flow of excessive government spending, rapid injection of money supply into the domestic economy that is out-of-line with the budgetary procedures, and the increased political demands of public office holders. Interestingly, the value of GDP growth is positive and significant at 5.5% and further to 6.67%, 14.6% and 9.50% in 2000, 2001, 2002 and 2003, respectively. Furthermore, the inflation level averaged 16.6% in 2001, 12.2% in 2002 and 23.8% in 2003. The value was targeted to be 7.0%, 9.30% and 9.00% from 2001, 2002 and 2003 respectively, but recorded an outcome of 16.5%, 12.20% and 23.80% respectively [43]. However, the rate of 10% targeted for the year 2004 was achieved. Although the rates seem to be fluctuating within double-digit across the years, but the policies of debt reduction implemented in 2003 by the Obasanjo's administration has largely contributed in checkmating the raising inflationary trend. The inflation value later dropped to an average of 8.5% in 2006 and 6.6% in 2007, but later recorded an increased value of 15.1% in 2008. From the year 2009, the value begins to decrease to 13.9%, and later 11.8% in 2010, 10.31 in 2011 and 12% in 2012, respectively. While the GDP growth produces an average of 7-9% between 2005 and 2012. This is attributed to poor fiscal discipline and monetary management of the then administration which is intensified by the government increase in domestic borrowing, hence, increasing the cost of borrowing and crowded-out the needed productive private sector investments. From 2013 to 2015, the rate of inflation and GDP growth continues to produce a fluctuating performance from 7.96%, 7.98%, to 9.55%, and 5.49%, 6.22% and 2.79%, respectively. Lack of sound framework for macroeconomic policies in developing countries posed a serious challenge to inflationary management, as it affects any meaningful decision-making and productive investment.

#### **4. CHALLENGES AND EFFECTS OF INFLATIONARY MANAGEMENT IN NIGERIA**

Depending on individual countries across the globe, the challenges posed by high inflation and its macroeconomic effects on growth is a function of essential economic factors including effects on productive decision making by individual investment, and gradual eroding of economic and social welfare which eventually results to lower output growth. High inflation has evidently established to be detrimental in the realisation of sustainable growth and development particularly in the developing countries of sub-Saharan Africa. The challenges of inflation can be contingent on an enormous number of scenarios. Changes in consumption patterns may be impending in any given situation where an increased set of prices are chasing similar bundle of goods and services over an extended period of time, while real consumer income relatively remains constant. This, however, not only produce an insignificant effect on consumption capacity and social welfare but further largely affects the sustainable rate of economic growth in the long-run through decreased in savings and investment, heighten the poverty indices, and reduces the international competitive drive of the economy. Any increased and unstable inflation rate that is challenging to predict, causes a short-term contract arrangement between the workers and employers, which may results to uneconomical renegotiations in the future. Another challenging aspect of sustained increased in the inflation rate is the value depreciation of the local currency which relatively affects the exportable commodities and intensified the growing deficit in the balance of payment.

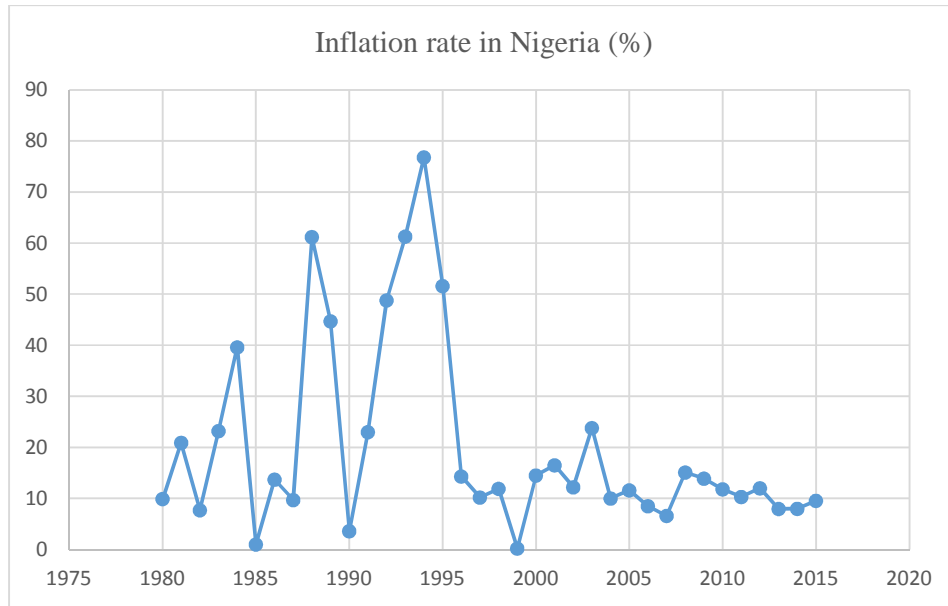
The rising inflationary regimes affect the decision-making and other organisational business plans based on the available numerical data. Although, this may depend on organisational size, the scale of operation, types of business formation, and the region of business. Any meaningful attempts to subdue the effects of sustained inflation will be made only when the inflationary trend is not spiral but low. Otherwise, it will imposed daunting challenges on productive activities designed towards market-driven growth or other economic policy for national sovereignty. An essential reason to subdue the current inflation level is to avoid reaching a certain point where the effects alluded to may be difficult to manage. If not

controlled, the overall effect will intensify the speedy process of getting to recessionary level. The difficulties posed by inflation is not limited to specific regions or to transitions and emerging market economies of the globe, but it is also a major challenge to the developed countries. The further challenges posed by sustained high prices is scaffold and grounded on the negative effects which inflation imposed on domestic macroeconomic conditions with a high prospect of derailing the economy from attaining the desired level of growth. It also affects the development of the financial sector, heightens the growth of inequality and income distribution, encourages uncertainty in the macroeconomic management, increases social cost among the citizenry, and largely affect the aggregate output growth in the domestic economy.

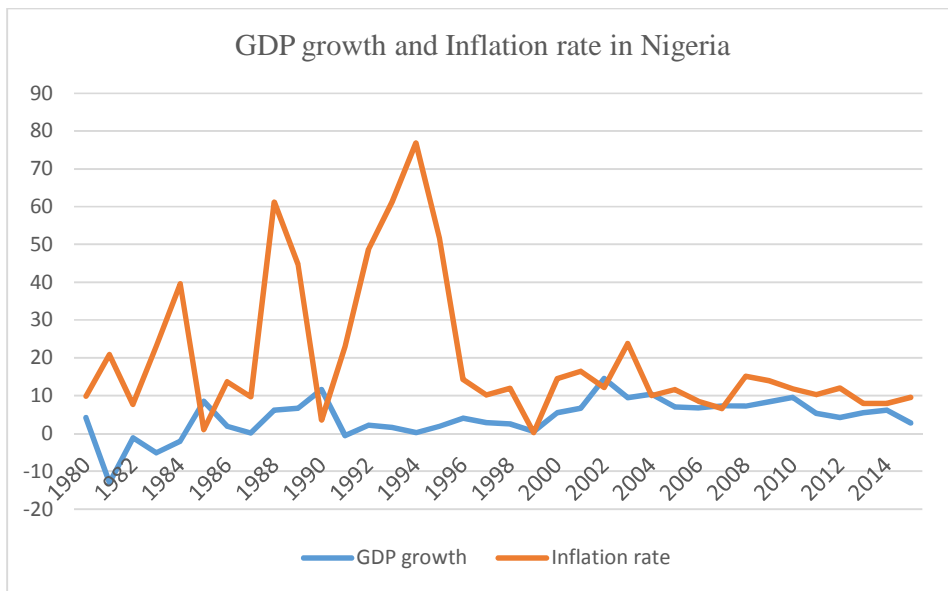
In addition, sustained increased in inflation rates will produce negative effects on the real interest rate especially when the nominal rate of interest are fixed. Hence, returns on financial asset may be negative and will discourage stakeholder and other prospective investors. As a result, demand for a productive financial asset with high potentials of future savings will ultimately decrease. As the prospective investors fully became abreast of the effects and challenges of sustained inflation rates through a decrease in the value of dividends, they will rationally change the investment decisions to other domain of productivity whose returns provide an edge against the inflationary trend. As a result, the demand for loanable funds in the financial sector (commercial bank for example) will certainly decrease and thus, affect the tempo of economic activities, growth of consumer income and the aggregate national income. Another dimension of negative challenges of inflation on the growing economy is the effects on domestic cost of production which virtually dampens investment decision in the economy thus, giving more rise to importation of commodities and capital flight at the cost of export which should have been produced locally to avoid any undesirable effects on the current account balance particularly the non-oil goods. The disposable income of the growing population will also reduce in value which may encourage the labour unions to agitate for higher payment. The incessant cases of labour agitations have a significant and negative effect on the economy as output is drastically reduced, and priority sectors like health and education are immensely being affected. When there is growing service cut from

these essential sectors, human capital development is undermined and further affect the desire to attain the sustainable level of growth. Beside human development, the growth of capital formation is also constrained by the inflationary pressure which is required for effective distribution to capital and money market

for competitive utilisation with the view to ensure balanced growth in the economy. A country must invest a significant amount of capital stock into productive ventures if they are to develop, hence, capital formation is a necessary and essential condition for macroeconomic growth and development.



**Fig. 1. Fluctuating trend of inflation rate in Nigeria**  
 Source: Author's computation (2017) using CBN statistical bulletin (2015)



**Fig. 2. Trend of GDP growth and inflation rate in Nigeria**  
 Source: Author's computation (2017) using CBN statistical bulletin (2015)

## **5. CONCLUDING REMARKS**

One of the key macroeconomic challenges threatening output growth in Nigeria is the inflation rate. The rate of inflation over the last three decades in Nigeria has significantly increased thereby affecting the macroeconomic growth and international competitive drive of the growing economy. The magnitude of this inflationary trends may be largely explained by the rapid growth of money supply motivated by the expansionary fiscal policies of the public sector, in addition to exchange rate fluctuation and poor diversification of the economy. After numerous attempts by successive administrations to regulate this economic problem using both monetary and fiscal policies, efforts seem to be abysmal. Thus, identifying the possible relationship between inflation and economic growth may expedite the process of realising the feasible policy options to be adopted towards achieving sound macroeconomic growth. Although, inflation can produce diverse effects on real output growth, that effect depend on the causes of inflation and the general macroeconomic conditions in that particular country. Moreover, in order to identify and understand the nature of an existing link between inflation and real output growth rate, it is essential to determine the sources of inflation and the circumstances surrounding output growth in such respective country, this will encourage the development and implementation of an effective economic policy that would restore the productivity level of the economy. Although, examining the inflation-economic growth nexus is necessary, it is not a sufficient condition for the development of an effective economic policy. It is against this background that this study adopted a descriptive method to provide better understanding on how inflation rate is affecting the desired level of economic growth in Nigeria. The paper therefore concludes that the current inflationary trend in Nigeria is negatively affecting the realisation of sustainable growth and development through declining growth rates. Thus, the result will serve as a working tool for policy makers and foreign investors who engaged in viable business opportunities. This implies that one of the necessary requirement for realising the desired growth level in Nigeria is to control the excessive increase in inflation rate. The need for government to designed suitable framework that will encourage the local producers to engage in innovative activities cannot be underestimated. This will provides the platform for creativity and manufacturing of

commodities with international competitive advantage. In the long-run, the multiplier effects of this framework is expected to increase the export volume of the growing economy, raise productivity level and competitive drives, increase employment creations, raise income growth and economic welfare. This is necessary for the attainment of desired level of inflation, exchange rate stability in relation to the currency of industrialised economies, and largely the fiscal prudence and macroeconomic growth. Furthermore, fiscal discipline should be fully implemented and sustained such that public sector expenditures are allocated to the desired and productive units of the economy. By so doing, misappropriation of public funds and large-scale diversion of government resources to private uses are checked, as they, to some extent, contributes to inflation.

## **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

## **REFERENCES**

1. Erbaykal E, Okuyan HA. Does inflation depress economic growth? Evidence from Turkey. *International Research Journal of Finance and Economics*. Euro Journals Publishing, Inc. 2008;17:41-48.
2. Iyke N, Takumah W. The links between economic growth and tax revenue in Ghana: An empirical investigation. MPRA Paper No. 67281, Munich Personal RePEc Archive; 2015.
3. Umaru A, Zubairu AA. Effect of inflation on the growth and development of the Nigerian economy: An empirical analysis. *International Journal of Business and Social Science*. The Special Issue on Social Science Research, Centre for Promoting Ideas, USA. 2012;3(10):183-191.
4. Thanh SD. Threshold effects of inflation on growth in the ASEAN-5 countries: A panel smooth transition regression approach. *Journal of Economics, Finance and Administrative Science*. Elsevier B.V. 2015;20(2):41-48
5. Vinayagathan T. Inflation and economic growth: A dynamic panel threshold analysis for Asian economies. *Journal of Asian Economics*. Science Direct Elsevier Inc. 2013;26(2):31–41.

6. Eggoh JC, Khan M. On the nonlinear relationship between inflation and economic growth. *Research in Economics*. 2014;68(1):133–143.
7. Ahmed S, Mortaza MG. Inflation and economic growth in Bangladesh. Bangladesh Bank Working Paper Series: Paper no. WP 0604; Policy Analysis Unit (PAU), Research Department, Bangladesh Bank; Dhaka, Bangladesh; 2005.
8. Isik TT, Sahin I, Aydinkaya I. Consumer confidence index, the relationship between growth and inflation: A case of Turkey. *International Journal of Economics, Commerce and Management*. United Kingdom. 2016;4(4):295-306.
9. Zhumadilov E, Kozubekov A. Analysis of the relationship between the dynamics of inflation and economic growth in Kyrgyzstan. National Bank of the Kyrgyz Republic (NBKR). NBKR Working Paper. Authorised for distribution by the Scientific and Expert Council of the NBKR. 2013;1-28.
10. Samuel H, Nurina S. Analysis of the effect of inflation, interest rates, and exchange rates on Gross Domestic Product (GDP) in Indonesia. *Proceedings of the International Conference on Global Business, Economics, Finance and Social Sciences (GB15\_Thai Conference)*, Bangkok, Thailand. 2015;1-13.
11. Bick A. Threshold effects of inflation on economic growth in developing countries. *Economics Letters*. Elsevier B.V. 2010; 108(2):126-129.
12. Mahmoud LOM. Consumer Price Index and economic growth: A case study of Mauritania. *Asian Journal of Empirical Research*. Published by Asian Economic and Social Society. 2015;5(2):16-23.
13. Bhusal TP, Silpaka S. Growth and inflation: Estimation of a threshold point for Nepal. *Economic Journal of Development Issues, Combined Issue*. 2011;13-14 (1-2):131-138.
14. Mubarik YA. Inflation and growth: An estimate of the threshold level of inflation in Pakistan. *SBP-Research Bulletin*. 2005; 1(1):35-44.
15. Bawa S, Abdullahi IS. Threshold effect of inflation on economic growth in Nigeria. *CBN Journal of Applied Statistics*. 2012; 3(1):43-63.
16. Pesaran MH, Shin Y, Smith RJ. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*. 2001;6:289-326.
17. Tanwar R. Nexus between inflation and economic development in India. *International Journal of Humanities and Social Science Invention*. 2014;3(9):63-67.
18. Birman A. Some empirical aspects regarding the relationship between inflation and economic growth in Romania – the speed limit effect. *European Journal of Interdisciplinary Studies*. 2011;3(2):55-76.
19. Ferdous M, Shahid EM. Study on nature of inflation and its relationship with GDP growth rate: A case study of Bangladesh. *IOSR Journal of Economics and Finance*. 2013;1(3):40-49.
20. Venkadasalam S. The determinant of consumer price index in Malaysia. *Journal of Economics, Business and Management*. 2015;3(12):1115-1119.
21. Mallik G, Chowdhury A. Inflation and economic growth: Evidence from four South Asian Countries. *Asia-Pacific Development Journal*. 2001;8(1):123-135.
22. Ahoritor CRK, Adenekan A, Ohemen W. An estimate of inflation threshold in the WAMZ: The case of Ghana and Nigeria. *Journal of Monetary and Economic Integration*. 2010;11(2):158-201.
23. Olu JF, Idih EO. Inflation and economic growth in Nigeria. *Journal of Economics and International Business Management*. Science Web Publishing. 2015;3(1):20-30.
24. Igbatayo S, Agbada AO. Inflation, savings and output in Nigeria: A VAR Approach. *Journal of Emerging Trends in Economics and Management Science (JETEMS)*. Scholarlink Research Institute Journals. 2012;3(5):447-453.
25. Babatunde MA, Shuaibu MI. Money supply, inflation and economic growth in Nigeria. *Asian-African Journal of Economics and Econometrics*. 2011;11(1): 147-163.
26. Al-Zeaud HA. An investigation of granger causality between oil price, inflation and economic growth in Jordan. *Global Journal of Management and Business Research: (B) Economics and Commerce, Version 1.0*. Double Blind Peer Reviewed International Research Journal, Published by Global Journals Inc., USA. 2014; 14(6):33-41.
27. Mohaddes K, Raissi M. Does inflation slow long-run growth in India? Seminar paper presented at the IMF Asia and Pacific Department, Discussion Forum and the

- Third Indian Statistical Institute Delhi Macroeconomics Workshop. 2014;1-17.
28. Saaed AAJ. Inflation and economic growth in Kuwait: Evidence from cointegration and error correction model. *Applied Econometrics and International Development*. 2007;7(1):143-155.
29. Apergis N. Inflation, output growth, volatility and causality: Evidence from panel data and the G7 countries. *Economics Letters*. Elsevier, Science Direct. 2004;83:185–191.
30. Olubodun OO. Nigeria economy growth and inflation drift system. *Journal of Social Sciences and Humanity Studies*. TextRoad Publication. 2015;1(3):1-6.
31. Gokal V, Hanif S. Relationship between inflation and economic growth. Working Paper series; paper no. 2004/04, Economics Department, Reserve Bank of Fiji; 2004.
32. Datta K, Mukhopadhyay CK. Relationship between inflation and economic growth in Malaysia: An econometric review. *International Conference on Economics and Finance Research, IPEDR*. IACSIT Press, Singapore. 2011;4:415-419.
33. Wilson BK. The links between inflation, inflation uncertainty and output growth: New time series evidence from Japan. *Journal of Macroeconomics*. Elsevier, Science Direct. 2006;28:609-620.
34. Denbel FS, Ayen YW, Regasa TA. The relationship between inflation, money supply and economic growth in Ethiopia: cointegration and causality analysis. *International Journal of Scientific and Research Publications*. 2016;6(1):556-565.
35. Laurrabaquio OP. The Non-linear relationship between inflation and economic growth in Mexico. *Problemas del Desarrollo, Revista Latino America De Economia*. Universidad Nacional Autonoma de Mexico. 2014;45(177)1-24.
36. Frimpong JM, Oteng-Abayie EF. When is inflation harmful? Estimating the threshold effect for Ghana. *American Journal of Economics and Business Administration*. Published Science Publications. 2010; 2(3):232-239.
37. Leshoro TLA. Estimating the inflation threshold for South Africa. *Economic Research Southern Africa (ERSA)*. ERSA working paper 285. A research programme funded by the National Treasury of South Africa; 2012.
38. Kasidi F, Mwakanemela K. Impact of inflation on economic growth: a case study of Tanzania. *Asian Journal of Empirical Research*. Asian Economics and Social Society (AESS). 2014;3(4):363-380.
39. Epaphra M. Nonlinearities in inflation and growth nexus: The case of Tanzania. *Journal of Economics and Political Economy*. 2016;3(3):471-512.
40. Marbuah G. On the Inflation-growth nexus: Testing for optimal inflation for Ghana. *Journal of Monetary and Economic Integration*. 2010;11(2):54-82.
41. Chimobi OP. Inflation and economic growth in Nigeria. *Journal of Sustainable Development*. 2010;3(2):159-166.
42. Hossain A. The Granger-causality between money growth, inflation, currency devaluation and economic growth in Indonesia. *International Journal of Applied Econometrics and Quantitative Studies*. Journal IJAEQS published by EAAEDS. 2005;2(3):45-68.
43. Central Bank of Nigeria. *Statistical Bulletins*; 2015.

© 2017 Idris and Bakar; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*  
*The peer review history for this paper can be accessed here:*  
<http://sciencedomain.org/review-history/19059>