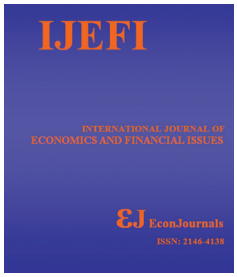

International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2017, 7(5), 41-52.

Public Debt Carrying Capacity and Debt Transmission Channels: The Nigerian Experience

Bassey Okon Ebi[1]*, Imoke Douglas Imoke[2]

[1]Department of Economics, University of Calabar, Calabar, Nigeria, [2]Department of Economics, University of Calabar, Calabar, Nigeria. *E-mail: ukotebi@yahoo.co.uk

ABSTRACT

Public debt is good but also harmful depending on the level of accumulation and its management. Different levels of public debt is said to have varied impact on growth and since a tolerable public debt level is necessary for economic growth, then, the rising public debt, low investment and non-inclusive economic growth in Nigeria is something to worry about. This study therefore, empirically investigates the debt growth relationship in Nigeria for the period 1970-2014. Quadratic function was employed in modeling the various relationship of interest. Error correction mechanism technique was applied to estimate the models. The results showed public debt to gross domestic product (GDP) ratio was positive while the squared of public debt to GDP was negative and statistically significant at 5% level in the different equations. The result supported the presence of non-linearity as the positive coefficient of public debt at the lower level and negative coefficient at higher level demonstrates an inverted U-curve in the debt growth relationship. The study further indicated that the optimal debt carrying capacity of Nigeria is 29.7% debt GDP ratio. This implies that, the level of borrowing in Nigeria should not exceed this threshold otherwise it will exert a negative impact on the economy. The result also suggests that, investment, interest rates and private savings are channels through which public debt impact on economic growth in Nigeria. The paper recommended that due attention should be given to existing debt level before contracting new loans to avoid the economy being thrown into debt overhang. Borrowed funds should be channeled properly to investment in order to boost economic growth.

Keywords: Public Debt, Carrying Capacity, Channels, Nigeria
JEL Classifications: H63, O4

1. INTRODUCTION

The relationship between public debt and economic growth has been studied extensively over the years with mixed results. Some results showed positive relationship between public debt and economic growth (Sulaiman and Azeez, 2012; Qayyum and Haider, 2012) others revealed a negative relationship (Atique and Malik, 2012; Safdari and Mehriizi, 2011).

Arising from this mixed results, some theories emerged to explain that the debt-economic growth nexus may be cyclical (example, debt overhang hypothesis, laffer curve and debt cycle hypothesis). For instance, the debt overhang theory explained that if debt will exceed the country's repayment ability with some probability in the future, expected debt service is likely to be an increasing function of the country's growth. Thus, some of the returns from investing in the domestic economy are effectively "taxed" away by existing foreign creditors and investment by domestic and new foreign investors are discouraged. Under such circumstances, the debtor country shares only partially in any increase in output and exports because a fraction of that increase will be used to service the external debt. The theory implies that debt reduction will lead to increased investment and repayment capacity and, as a result, the portion of the debt outstanding becomes more likely to be repaid. When this effect is strong, the debtor is said to be on the 'wrong side' of the debt Laffer curve. In this case, the debt Laffer curve refers to the relationship between the amount of debt repayment and the size of debt. The idea of debt Laffer curve also implies that there is a limit at which debt accumulation stimulates growth (Elbadawi et al., 1996; Ebi et al., 2013). In reference to debt Laffer curve, Lensink and White (1999) argue that there is a threshold at which more debt is detrimental to growth. This threshold defines the debt carrying capacity of a country.

Public debt carrying capacity is the maximum amount of debt that a country can owe beyond which the country's income or growths can no longer increase. McKinny (2004) emphasized the imperatives of knowing the debt-carrying capacity of a government because it shows or indicates how much the government may reasonably borrow.

Apart from the impact of debt on economic growth and debt carrying capacity, there is also concern about the channels through which debt influences economic growth. It is possible that economic growth enhancing factors may be influenced by public debt thereby affecting growth itself (Clement et al., 2003; Checherita and Rother, 2012).

The channel through which public debt transmit its effect on economic growth are mixed. Some studies suggest capital accumulation as the only transmission mechanism (Kumar and Woo, 2010; Clement et al., 2003) while some found private savings and interest rates as channels (Pescatori et al., 2014). Others included growth of total factor productivity (TFP) as one of the channels (Checherita and Rother 2012; Kehinde et al., 2015; Riffat and Munir, 2015).

Though there are a plethora of literature that dwells on debt and economic growth relationship, few focused on transmission channels. While Kumar and Woo (2010) conducted their study for advanced countries without differentiating the developed and emerging countries, Checherita and Robert (2012) covered Euro zones area and none of these was a country specific study. This present study is country-specific and centered on Nigeria.

Accordingly, a cursory examination of debt trend in Nigeria shows that, the debt stock increased by 96.8% between 1986 (₦69891.10 million) and 1987 (₦137578.20 million). External debt jumped from ₦633017 million in 1998 to ₦2577374.40 million in 1999, about 307% increase. On the other hand the domestic debt component rose by 47.9% from ₦537490.90 million to ₦794806.60 million, within the same period. By the year 2004 the total debt stock had risen to ₦6.261 Trillion with external debt taking about 78% share while the domestic debt had about 21.8% share of total debt. However, within 2004 and 2006, total debt stock recorded about 64.8% fall from ₦6.260 trillion to ₦2.204 trillion due to the implementation of Phase I and II of the Paris Club debt deal (Debt Management Office [DMO], 2012). The debt relief reduced drastically, the external debt to ₦451.46 Billion in 2006 which was about 20% of total debt. The country's debt stock that was reduced to ₦2.204 trillion in 2006 rose to ₦12.12 trillion in second quarters of 2015.

Further stylize facts also reveals that Nigeria recorded an average gross domestic product (GDP) growth of 5.91% from 2005 to 2015. Total debt to GDP ratio was 20.58% in 2011 and 22.43% in 2012. This however declined in 2014-12.65%. This debt GDP threshold seems sustainable. However, the improvement in debt GDP indicator was due to the re-basement of the Nigeria's economy. The DMO had cautioned the federal government in December, 2015 against brokering new debt deals because the debt-GDP does not automatically translate to an equal growth in revenue and therefore enhance capacity to service debt. This is clearly revealed in the close range of debt service threshold of 25.7% which is fast approaching 28% maximum.

The rising public debt trend and non-inclusive nature of growth in Nigeria necessitated the following pertinent questions. Is the impact of public debt on economic growth in Nigeria nonlinear? What is the optimal debt carrying capacity for Nigeria? Can additional accumulation of debt have varying impact on economic growth? What are the possible channels through which public debt impacts on economic growth in Nigeria? Answers to these questions are necessary for policy articulation.

2. LITERATURE REVIEW

2.1. Theoretical Framework

This paper reviewed the following theories considered to be related and relevant to the debt-economic growth relationship. The theories include; debt overhangs hypothesis, debt cycle hypothesis, the neoclassical debt model, and the two gap model of Chenery and Strout.

2.1.1. Debt overhang and debt relief

Debt overhang could be traced to corporate finance literature. The theory of debt overhang by Myers in1977 indicates a situation in which a firm's debt is so large that any returns from new investment projects are entirely appropriated by existing debt holders. Hence projects with a positive net present value cannot reduce the firm's stock of debt. The debt crisis in the 1980s informed writings of (Krugman, 1988) and others who argued that sovereign government service their debt by taxing firm and households. Reinhart and Rogoff (2010) described the deterioration of the economy due to an increase in public debt as debt overhang. Debt overhang is not limited to low growth but that it coexists with low interest rate (Kobayashi, 2015). Countries that suffer from debt overhang are characterized by a situation in which partial debt forgiveness that reduces the expected tax burden can make both lenders and borrowers better off by enhancing investment and growth. This will also enhance tax revenue and the value of debt (Krugman, 1988).

It is believed that debt overhang is removed when public debt relief is granted to countries who were servicing their debt. Debt relief creates fiscal space in investment for economic growth to countries that benefit from it and make them return to the path of development process. With the help of the World Bank and international monetary fund (IMF), creditor nations introduced debt relief/cancellation in 1996 and 1999 to heavily indebted poor countries of the world as a way of removing the impediment of debt burden on economic growth (Ekperiware and Oladeji, 2014). The problem of debt overhang informed the use of certain indicators known as debt threshold to monitor the sustainability of countries debt. The debt thresholds are the indicators that indicates the benchmark or limit to debt of a country beyond which debt becomes a serious burden and unsustainable. The threshold schools of thought are concerned about the non-linear relationship between debt and growth (Calvo, 1998).

2.1.2. Public debt cycle hypothesis

Poghosyan (2015) hypothesize that, a complete public debt cycle comprises two phases (i) the expansion phase (from trough to peak); and (ii) the contraction phase (from peak to trough). The main characteristics of cyclical phases are duration, amplitude, and slope. The duration of expansion is the number of years between a trough and the next peak (measured in years). The amplitude of expansion measures the change in debt-to-GDP ratio from trough to the next peak (measured in percent of GDP). The slope of expansion is the ratio of its amplitude to duration (measured in percent of GDP).

2.1.3. The neoclassical debt model

The neo classical debt model developed by Peter Diamond in 1965 is of the view that debt finance has a potential impact on capital formation. The model stresses that when government initiates a project whether financed by tax or borrowing, resources are removed from the private sector assuming that tax is used at the expense of consumption. But when the project is financed by government through borrowing, it competes for funds with individuals and firms who want the money for their own investment projects. Therefore, the general assumption is that public debt has its effect on private investment. Accordingly, debt financing causes a reduction of capital stock for the future generation making its members (generation) produce less and have smaller real incomes (Rosem, 1992).

2.1.4. The two gap model

Two gap model was developed by Chenery and Strout in 1965 as an extension of the Harrod-Domar model of 1946 to take care of an open economy. Chinery and Strout observed that two gaps (savings and foreign exchange) exist and they are constraint to the attainment of a target growth rate (Jhingan, 2002). The savings gap occur when the domestic savings rate falls short of the investment required to achieve the target growth while the foreign exchange gap exist when the target export earnings fall below foreign exchange requirement. These two gap can be closed with the injection of resources from abroad. According to Chenery, the savings gap can be closed with foreign aids inform of loan, grants and foreign direct investment (FDI). Equally the foreign exchange gap can be closed with aids as well.

2.2. Review of Empirical Literature

2.2.1. Debt and economic growth

The relationship and impact of debt on economic growth had been studied empirically both locally and internationally and results are varied. Some results shows a positive relationship between output and debt (Bakar and Hassan, 2008; Sulaiman and Azeez, 2012; Qayyum and Haider, 2012) others revealed a negative relationship, (Calderon and Fuentes, 2013; Atique and Malik, 2012), Safdari and Mehriizi (2011).

Bakar and Hassan (2008) investigated the effect of external debt on economic growth of Malaysia using a time series data over the period 1970-2005. The study applied the vector autoregressive method (VAR) in estimating the model. The result revealed a positive effect of debt on the growth of the Malaysia economy.

Sulaiman and Azeez (2012) examined the effect of external debt on the economic growth in Nigeria. The study employed the co-integration and error correction mechanism (ECM) on the time series data covering a period of 1970-2010. The study revealed that external debt has a positive effect on economic growth suggesting that accumulation of external debt in Nigeria will enhance the economy.

Egbetunde (2012) investigated the causality between public debt and economic growth and their effect. The study focused on Nigeria over a period 1970-2010. The study employed the co-integration and VAR method. The result indicated that, there exist a bi-directional causality between public debt and economic growth in Nigeria. The finding also revealed that domestic debt promotes economic growth better than foreign debt.

Ebi et al. (2013) investigated the relative impact of domestic and foreign debt on economic growth in Nigeria. They used time series data over the period of 1970-2011 and also employed the vector ECM. Their result suggests that external debt has more impact on economic growth than domestic debt. The implication of results of this nature is that the country should rely on foreign debt than domestic debt.

A number of studies indicating negative impact of public debt on economic growth are also reviewed. Obademi (2012) studied the impact of debt on economic growth in Nigeria using error correction techniques on time series data spanning 1975-2005. The result indicated a negative impact of debt on economic growth in the long run while in the short run the debt was positive. This implies that a long run debt burden would depress economic growth. Obademi (2012) opined that Nigeria debt over hang over the years could not allow the available resources to achieve the desired rate of economic growth. One of the weapons suggested to have influenced Nigeria's heavy debt was the desire to have a simultaneous growth in all the sectors of the economy following the doctrine of the balanced growth. These sectors which directly or indirectly influenced investment includes: The power sector, agricultural irrigation and transport. In another study of Obademi (2013) on external debt and Nigerian economic growth nexus; matters arising, a negative relationship between external debt and economic growth was observed. An analysis of the impact of these variables was made using a simple regression method ordinary least squares (OLS) on a time series data spanning 1981-2011. He argued that the huge external debt burden of Nigeria after several years was a direct after-effect of the structural adjustment programme introduced in 1986 by the federal government. Debt servicing according to him took a greater percentage of the resources that would have been invested in the non-oil sector which would have led to greater economic growth and development.

Udoka and Ogege (2012) empirically investigated the relationship between public debt and Nigeria's development crisis. The co-integration and error correction method was used in analyzing the effect of debt servicing, debt stock, foreign investment and political stability on per capita GDP (PCGDP). They used time series data covering a period from 1970 to 2010. The findings revealed a significant effect of debt on economic growth. This

informed their recommendation against the countries reliance on public debt both domestic and foreign.

In another study carried out by Izedonmi and Ilaboya (2012) on public debt growth dynamics, the co-integration and error correction method was used on time series data over a period of 1980-2010. The study suggested a negative relationship between public debt burden and growth in Nigeria. They also found that the ratio of debt services to export was negatively related to economic growth.

Calderon and Fuentes (2013) studied debt and growth with the dual aim of examining whether debt growth relationship and whether economic policies ameliorate the effect of debt on growth. The study was carried out for the Latin America and Caribia region over the period 1970-2010. It was observed that, reduction in public debt and improved policy environment enhances and increase the growth per capital income in the Caribia and the South America economies. Specific variables that helped mitigated the adverse impact of debt burden on growth were institutional quality, domestic policies and exports.

2.2.2. Empirical literature on debt carrying capacity (debt turning point [DTP])

A number of studies have investigated whether the impact of public debt on economic growth is non-linear as well as debt carrying capacity for countries. For instance, Saddique and Malik (2002) explained the nature of the relationship between debt and growth in South Asia countries of Ericartea, Pakistan and India. They carried out a test on the non-linearity in the debt-growth relationship and used the OLS and fixed effect method on the countries data covering 1975-1998. The result suggests that, debt increases economic growth to a certain level after which stagnation of the economy arises.

Cordella et al. (2005) examined the link between debt/growth and explored the relationship between the level of indebtedness and other country characteristics in developing countries. The result suggests that, there is a negative marginal relationship between debt and growth at intermediate levels of debt. Accordingly countries with good debt management policies suffer debt over-hang when debt rises above 15-30% of GDP but marginal effect of debt and GDP growth are ineffective at when debt rises above 70-80%.

Checherita and Rother (2012) investigated the impact of high government debt on economic growth in twelve Euro area countries namely; Austria, Belgium, France, Greece, Ireland, Finland, Germany, Luxembourg, Portugal, Spain, Netherland and Italy over a 40 years period (1970-2010). They employed the panel fixed effect and the generalized method of moments (GMM) to estimate their model. They found out that debt has a non-linear impact on growth. There exists a turning-point of 90-100% of GDP beyond which debt will have a negative effect on long term growth. They also found that Investment, TFP and private savings are the channels through which debt impact on growth. This study differed from the previous study.

Mercinger et al. (2014) conducted a study for 25 European Union (EU) countries comprising the old and new members of the EU. They empirically examined the transmission mechanism of public debt on growth. They employed annual dataset of these countries, from 1995 to 2010 and used the panel estimation method. Findings from the study suggest that there exist a significant non-linear impact of debt on PCGDP growth rates. The study further revealed that DTP for the old EU members is between 80% and 94.1% and 53% and 54% for the new EU member beyond which debt would adversely impact on growth. Mercinger et al. failed to explore the channels through which this adverse impact could be transmitted on growth. They admitted that their findings were not subjected to robustness check which may cause bias in their result.

Pescatori et al. (2014) examined the possible debt GDP threshold using IMF data set from 16 advanced and developing countries and tracing the debt growth in 15 years time horizons. The study concluded that there is no evidence of a particular threshold above which medium term growth prospect are compromised. The study, further found out that debt trajectory remains very vital as the level of debt exploring the future economic growth prospect. The study considered rise in debt as resulting to higher volatility in output growth which may be damaging to the economy. According to Pescatori, higher but declining debt countries grew along-side lower debt countries.

In determining the optimal public debt, Allan and Kari (2014) investigated the nexus between public debt and growth and also the issue of non-linearity in 13 states. They employed the panel dynamics OLS estimation and also the threshold dynamics of the Blanchard (1983) in order to calibrate an optimal debt/GDP ratio for each of the 13 countries. The crowding out hypothesis was tested by examining debt investment relationship. The result supports the existence of a non-linear relationship of debt/GDP. The result further revealed that the average threshold for the 13 countries was 61% beyond which debt would be negative.

Kumarasinghe and Purankumabura (2015) were interested in the effect of public debt on the growth of the Sri Lankan economy. They analyzed the impact of debt stock and economic growth in Sri Lanka using data spanning over 50 years from 1963 to 2012. The econometric method adopted in their study was the GMM after testing for unit root using the Augmented Dickey-Fuller (ADF) test. The result indicated the presence of a nonlinear relationship between public debt and economic growth in Sri Lanka with a turning point of 61% debt GDP ratio.

2.2.3. Empirical literature on channels through which public debt impact on economic growth

Few studies have focused on the channels through which debt impacted on growth. Presbitero (2005) examined the channels through which rising debt affects investment and economic growth. The study covered 152 developing countries over the period 1977-2002. The study applied the panel estimation method on the secondary data. The result suggested a negative external debt relationship with economic growth and between debt services and investment. It was also observed that the effect was stronger in the low income and debt impaired economic growth

through liquidity constraint and also causes macroeconomic instability.

Akram (2012) examined public debt consequences on economic growth and investment channel in Pakistan for the period 1972-2009 using autoregressive distributed lag model. The result obtained from the study revealed that external debt has a negative relationship with PCGDP and investment in both short and long-run. This could be explained as the existence of crowding out effect of debt on private investment.

The Ricardian equivalence theorem is of the view that debt is neutral implying that debt has no impact on interest rate (Kinoshita, 2006). Kinoshita adopted the overlapping-generation model as introduced by Blanchard (1985) and Weil (1989). For Kinoshita, there is little effect of government debt on interest rate but concluded that though the effect of debt is small, the economic impact of large debt must not be ignored.

United Nations Conference on Trade and Development (2005) report suggests that; increase in debt servicing reduces the resources available for inputs thereby reducing outputs. Increase in debt increases the capital flows and thereby increasing the resources available for investment which in turn increases output. Higher debt stock seems to influence growth through their damping effect on both physical capital accumulation and TFP growth.

Blavy (2006) provided evidence of a significant negative relationship between total public debt and productivity growth in the study of Jamaican economy over the period of 30 years. Blavy opined that, high public debt had been associated with macro-economic uncertainty. It was also found out from the study that, public investment was crowded out by debt service which in addition adversely affected productivity.

As stated earlier, there is a plethora of literature that dwells on debt and economic growth relationship but few focused on transmission channels. The few studies that focused on transmission channels are mostly cross-country. Hence, this present study is country-specific and concentrates in Nigeria. The paper also estimates the optimal debt carrying capacity of Nigeria.

3. DATA AND METHOD

This section presentation the method employed in this study. It is designed to explain data and data sources, model specification, estimation technique and determination of optimal debt carrying capacity.

3.1. Data Set and Sources

Annual secondary data were used in the study. The data include PCGDP as a proxy for economic growth; public debt as a ratio of GDP; data on investment, interest rate, savings and TFP as possible channels of debt transmission; as well as other control variables such as Treasury bill rate (TBR), literacy rate (LITR), FDI, institutional quality, etc. The data were obtained basically from public institutions and published documents. This includes; Central Bank of Nigeria Annual Reports and Bulletins, Federal Office of Statistics (NBS), DMO. Information was also gathered from the internet, IMF and World Bank web sites.

3.2. Model Specification

The theoretical underpinning of this study is eclectic in nature as it cuts across the debt cycle hypothesis, the neoclassical debt-growth theory and the debt overhang theory. The study specified four equations; the first is the economic growth equation which is used to explain the nonlinear impact of debt on economic growth. Apart from explaining the nonlinearity effect, the growth equation is also the basis in estimating the optimal debt carrying capacity. The other three equations relate to the impact public debt has on economic growth sources. It is aimed at examining the channels which are capable of diffusing the effect of debt accumulation on economic growth. Though several channels of impact of debt may work simultaneously, it can also be estimated individually, Wong (2001), Checherita and Rother (2012). In this case the variables considered as debt channels are each taken as a dependent variable. Accordingly, the paper investigates the impact of public debt on investment, interest rates, and private savings.

3.2.1. Economic growth model

The economic growth model is based on the augmented Solow growth model. This model had variously been applied in many empirical studies such as Checherita and Rother (2012), Presbitero (2008), Riffat and Munir (2015). Economic growth proxy by PCGDP is the explained variable and is dependent on investment (INV), public debt (PDEBT) and public debt squared (PDEBTSQ) as the key variables. The inclusion of the variable PDEBTSQ is to capture the nonlinearity effect and also to enable the estimation of the optimal debt carrying capacity. Other explanatory variables that affect economic growth included in the model includes: Interest rates proxy by lending rate (LR), LITR proxy for labour force, institutional quality proxy by contract intensive money) and FDI as proxy for openness of the economy. Accordingly, we specified that:

$$PCGDP_t=F(PDEBT_t, PDEBTSQ_t, INV_t, LITR_t, TBR_t, LR_t, INSQ_t, TFP_t, FDI_t, U_t) \quad (1a)$$

Expressed in econometric form, Equation (1a) becomes;

$$PCGDP_t=a_0+a_1PDEBT_t+a_2PDEBTSQ_t+a_3INV_t+a_4TBR_t+a_5LR+a_6INSQ_t+a_7TFP_t+a_8FDI_t+a_9LITR_t+U_t \quad (1b)$$

Where,
$PCGDP_t$=GDP per capita (economic growth),
$PDEBT_t$=Public debt as a ratio of GDP,
$PDEBTSQ_t$=Public debt/GDP squared,
INV_t=gross national investment (gross fixed capital formation),
TBR_t=Treasury bill rate,
LR_t=Lending rate,
$LITR_t$=Literacy rate,
$INSQ_t$=Institutional quality (contract intensive money),
TFP=Total factor productivity,
FDI_t=Foreign direct investment,
U_t=Error term,
a_0=constant term or autonomous economic growth.

a_1-a_8 are coefficients that define the exact relationship between economic growth and the various determinants of economic growth as stipulated in the model.

The apriori expectations about the various coefficients are:

$a_0>0$, $a_1><0$, $a_2><0$, $a_3>0$, and $a_4<0$, $a_5<0$, $a_6>0$, $a_7>0$ and $a_8>0$.

3.2.2. Investment equation

The investment channel is anchored on the theory of debt over-hang that postulates that debt crowds out investment. The accelerator principle also postulates that, capital stock is proportional to output. This implies that, investment depends on output growth. Interest rate according to Keynes is the cost of capital. The rate of interest therefore affects the amount of capital accumulation (investment). In order to close the savings gap foreign capital inflow (FDI) is important (Chinery and Strout, 1965). Chinery suggests that, increase in foreign capital flows boost investment in a country. The investment equation is therefore specified as follows:

$$INV_t=b_0+b_1PCGDP_t+b_2PDEBT_t+b_3PDEBTSQ_t+b_4FDI_t+b_5INTR_t+b_6DSERV_t+V_t \quad (2)$$

The theoretical expectation is that:

$b_0>0$, $b_1>0$, $b_2><0$, and $b_3><0$, $b_4>0$, $b_5<0$, and $b_6<0$.

3.2.3. Interest rate equation

Interest rate here is expressed as dependent on debt/GDP ratio, PCGDP, savings, inflation and money supply. The model relied on that of Checherita and Rother (2012).

$$INTR_t=c_0+c_1PDEBT_t+c_2PDEBTSQ_t+c_3PCGDP_t+c_4INF_t+c_5MS_t+\varepsilon_2 \quad (3)$$

$c_1><0$, $c_2><0$, $c_3<0$, $c_4<0$ and $d_5>0$.

3.2.4. Savings equation

This model employs the neoclassical theory of savings. The theory suggest that savings is dependent on the rate of interest, and income. The two gap model shows that domestic Savings gap can be close with borrowing. Therefore, savings is dependent on interest rate, public debt, public debt square, FDI, PCGDP, and interest rate.

$$SAV_t=d_0+d_1PDEBT_t+d_3PDEBTSQ_t+d_4FDI_t+d_5INF_t+d_6INTR_t+d_7PCGDP_t+\varepsilon_4 \quad (4)$$

3.2.5. Estimation of DTP

The DTP was estimated using the formula introduced by Checherita and Rotter (2012), and adopted by other researchers like Apere (2013). This procedure involves estimating the non-linear combination of the public debt variables and finding the ratio of the estimated linear and non-linear debt coefficients multiplied by a scalar (-1/2).

The formular for DTP is:

$$DTP=a_1/a_2*-1/2 \quad (5)$$

Where,

a_1=The coefficient of the linear term (coefficient of debt/GDP),

a_2=The coefficient of the quadratic (nonlinear) term. That is, the coefficient of $(debt/GDP)^2$. We also confirmed the estimation of the optimal point using differentiation. We take the first and second derivative of public debt with respect to PCGDP. The first and second order condition for optimum states that, the first derivative of public debt to GDP should be equal to zero. The sufficient (second order) condition for optimum is that, the second derivative of the function should be <0 i.e., negative.

From the equation; $PCGDP=a_0+a_1PDEBT+a_2PDEBT^2$ (6)

$\partial PCGDP/\partial PDEBT=0$ and $\partial PCGDP^2/\partial^2 PDEBT<0$ (7)

The DTP therefore becomes the optimal debt carrying capacity (ODCC).

4. RESULTS

This section presents and discussed the empirical results of the various test conducted in order to examine the impact of public debt on economic growth in Nigeria, the optimal debt capacity and the various debt channels on growth.

4.1. Descriptive Analysis

Table 1 shows the descriptive statistics of the variables employed in this study. PDGDP ratio (PDEBT) averaged 35.3% over the period while PCGDP averaged 2914.27 billion naira. Investment has the mean of 57% of GDP; debt service to GDP ratio (DSERV) has the mean of 22.3%; savings to GDP ratio (SAV) was 8.45% on average and interest rate has the mean of 18.2%. Further analysis revealed that, PCGDP was at its maximum value of 5746.1 Billion Naira; Public debt to GDP was at its maximum with the value of 82.1% and investment had a maximum value of 1.72%. Also, savings rate and interest rate had maximum values of 36.1 and 23.2% respectively.

4.2. Presentation and Analysis of Unit Root Results

This work tested both ADF and Philip-Perron (PP) unit roots to determine the stationarity of the time series data employed in the regression analysis. This was necessary because of the assumption that regression analysis of economic time series should be stationary to avoid spurious regression. The stochastic nature of the non-stationarity data are capable of distorting econometric results and render it inappropriate for forecast. In order to check whether an employed data are stationary we adopted the ADF and PP tests.

An examination of result of the ADF test in Table 2 shows that, all variables were not stationary at level implying the acceptance of the null hypothesis of the presence of unit root. However, all the variables became stationary after the first difference as they were all integrated of the first order 1 (1). This is because the calculated ADF values were lower than the critical values at 5% level of significance, but after the first difference the values of the ADF became greater than the critical values at 5% level of significance. In the same vain the result of the PP also exhibited

similar pattern with all the variables integrating of the order I (1). Hence, PP test result is not reported here. A 1 (1) order of integration of the variables implies that, we cannot specify the models in their levels without the risk of obtaining spurious regressions unless they are cointegrated. It is therefore necessary to carry out a cointegration test.

4.3. Cointegration Result

The result of the Johansen co-integration tests is presented in Table 3 for the different models. The Eigen test indicated 4 co-integrating equations in the growth model and significant at 0.05 levels. In the same vein, investment model (INV) was also co-integrated at 0.05% significance level. Its max-igen test showed 2 co-integrating equations. Interest rate model and the savings model were also co-integrated. While the max-eigen test for the interest rate model indicated 2 co-integrating equations, the savings model indicated 1 co-integrating equation. The implication of this result is that though individual variables were non-stationary their linear combination made them stationary in the various models analyzed.

4.4. Presentation of Result of the Growth Model

First we estimated an over-parameterized economic growth model where log of real per capital GDP was regressed with first lag of initial per capital GDP, public debt and public debt squared and their first lags, public debt, investment and one year lag of investment, FDI, institutional quality and with its one year lags. The important and significant variables from this model were selected and estimated as the parsimonious model which showed a better result than the over parameterized form. The parsimonious result is presented in Table 4.

The result shown in Table 4 indicates that, the one year lag of PCGDP was positively related to economic growth in line with economic *apriori* condition. Log of PCGDP coefficient of 0.21 implied that, a 10% increase in the previous year's PCGDP led to about 2.1% growth in the economy. However, its impact was not statistically significant at 5% level giving the p-value of 0.10 which is greater than the 0.05. This result may be due to the fact that growth PCGDP is not inclusive as to cause a significant

Table 1: Descriptive statistics

Measures	INV	LITR	LR	PCGDP	PDEBT	PDEBTSQ	SAV	TBR	TFP
Mean	0.57	47.81	18.18	2914.27	35.29	1779.53	8.45	10.26	0.01
Median	0.46	51.10	19.49	3303.32	23.80	566.44	7.90	10.25	0.02
Maximum	1.72	73.40	36.09	5746.12	82.13	6745.33	23.24	26.90	0.20
Minimum	0.02	20.14	6.00	75.162	8.44	71.23	3.33	2.500	-0.18
SD	0.47	15.68	7.17	1673.17	23.37	2040.46	3.46	5.69	0.07
Skewness	0.73	-0.33	0.22	-0.51	0.66	1.03	2.01	0.59	-0.33
Kurtosis	2.69	1.81	2.31	2.22	1.90	2.63	9.12	2.93	3.80
Jarque-Bera	4.20	3.49	1.26	3.11	5.55	8.22	100.92	2.68	2.085
Probability	0.12	0.17	0.53	0.21	0.062	0.016	0.0000	0.261	0.35
Sum	25.68	2151.48	818.10	131142.4	1588.13	80078.92	380.32	461.83	0.66
Sum of squared deviations	9.81	10819.50	2263.45	1.23E+08	24030.99	1.83E+08	527.43	1426.23	0.24
Observations	45	45	45	45	45	45	45	45	45

Source: Author's computation using E-view econometric software. SD: Standard deviation, PCGDP: Per capita gross domestic product, TBR: Treasury bill rate, LR: Lending rate, LITR: Literacy rate, TFP: Total factor productivity

Table 2: Result of ADF unit root tests

Variables	5% critical value	At level	1st difference	Remarks
PCGDP	−2.929734	−1.154071	−8.088693**	I (I)
PDEBT	−2.933158	−1.6045	−4.321272**	I (1)
PDEBTSQ	−2.933158	−2.289642	−4.287292**	I (1)
INV	−2.935001	−1.029534	−5.445289**	I (1)
DSERV	−2.943427	1.167013	−5.794333**	I (1)
INSQ	−2.929734	−1.284395	−6.429829**	I (1)
FDI	−2.929734	3.976658	−8.272211**	I (1)
SAV	−2.929734	−2.474467	−7.145341**	I (1)
INTR	−2.929734	−2.239679	−7.419726**	I (1)
TBR	−2.929734	−2.332966	−7.228183**	I (I)
LITR	−2.936942	−2.01583	−4.911632	I (1)

Source: Author's analysis using E-view econometric software. *Denotes rejection of the hypothesis at 5% level. *Denotes 1% significance level, **5% significance level and, ***denotes 10% significance level. ADF: Augmented Dickey-Fuller, PCGDP: Per capita gross domestic product, TBR: Treasury bill rate, LR: Lending rate, LITR: Literacy rate, TFP: Total factor productivity, DTP: Debt turning point, FDI: Foreign direct investment

Table 3: Summary of co-integration results of the various models

Model for	Eigen value	0.05 critical value	Hypothesized no. of CE (S)
PCGDP	106.775	95.7537	At most 4*
INV	71.3775	69.8189	At most 2*
INTR	70.7935	69.8189	At most 2*
SAV	57.17597	46.23142	At most 1*

Source: Author's extraction from co-integration results provided by E-view econometric software. *Denotes rejection of the hypothesis at 5% level. PCGDP: Per capita gross domestic product

impact on current economic performance. Investment (INV) was positive and statistically significant. The result agreed with our *apriori* expectation and in consonant with economic theory. It also supports the findings of Aurangzeb and Haq (2012) that investment contributes positively to economic growth. A 10% increase in investment lead to about 1.9% increase in PCGDP growth within the period covered in the study.

1 year lag of TBR (-1) with the coefficient of 0.47 and t-statistic of 2.06 indicates a positive and significant relationship with economic growth. This implies that, increase in interest rate paid by the government (treasury bill rate) on borrowed fund could boost the economy. In contrast, the previous year LR (-1) had a negative coefficient of 0.66 and t-statistic of −2.21. The result implied that a 10% increase in the LR resulted to about 6.6% decline in the growth of PCGDP. The implication is that, high interest rates adds to cost of doing business and therefore discourages investment, this in turn affects output and the growth of PCGDP.

Importantly, Public debt components had a significant positive impact on economic growth. Public debt coefficient of 0.094 implied that an initial increase in government borrowing by 10% lead to about 0.9 increase in economic growth. The result is in line with theory which suggests that lower level of debt enhances growth. This also supports the finding of Riffat and Munir (2015). Public debt squared on the other hand was negative and statistically significant at 5% level. This negative coefficient of public debt square (−0.0015) suggest that, as the governments' borrowing doubled, it resulted to a decline in economic growth by 0.0015%. The result confirms that of Cordella et al. (2005) and Obademi (2012) whose finding revealed that impact of debt on Nigeria economic growth in the short run was positive and negative in the long run. Nigeria debt history has shown that in the 1980s high public debt was associated with low economic growth. In the case of the contribution of LITR, the result revealed that, 2 years lag (increase in LITR 2 years later) resulted in a significant positive impact on economic growth in Nigeria. TFP in the previous year was positive but not statistically significant. This result suggests that, technological progress has not impacted significantly on the growth of Nigeria economy.

The ECM appeared with the correct negative sign and was statistically significant at 5% level. The ECM coefficient of 0.14 indicates a very slow speed of adjustment from the short run disequilibrium to the long run equilibrium. The adjusted $R^2 = 0.54$ indicates that, about 54% of variation in economic growth was explained by the independent variables in the model. F = 5.75 indicates that variables are jointly statistically significant. D-Watson statistic with the coefficient of 2.1 exhibits non-existence of autocorrelation in the model. From above, it can be deduced that the result is good for policy.

Public DTP: The result in Table 5 showed that DTP is 29.7%. The implication of this result is that Nigeria's debt/GDP ratio is still a bit lower than its optimal level. Public debt tolerable level in Nigeria is therefore between zero and about 29% debt to GDP. Nigeria is therefore free to borrow until the debt/GDP ratio is about 29.7%, beyond which further increased indebtedness will result to lower growth. In computing the turning point, we adopted the procedure described in sub-section 3.2.5 (Equation 5).

4.5. Presentation and Analysis of Results of Public Debt Channels on Growth

In order to determine the channels of public debt and to examine the indirect effect of debt on economic growth, we regressed public debt variables on the various channels of growth. This procedure is in consonance with the one introduced by Wong (2001). According to him under channel decomposition, the growth determinants could influence economic growth through these channels earlier mentioned. Accordingly, public debt and its square were regressed against investment, interest rate and savings in order to determine the impact of public debt on each of them considered as possible channels. In line with Engle and Granger (1987) which stated that a system of integrated variables can be represented by a dynamic error correction model, we first estimated an over parameterized ECM model and then derived a parsimonious model (a more preferred specification) for better interpretation. However, results of the over-parameterized model are not reported here. The parsimonious results of various channels are discussed below.

Table 4: Parsimonious ECM result of economic growth equation

Variable	Coefficient	SE	t-statistic	P
C	0.037338	0.047497	0.786109	0.4380
Δ(Ln (PCGDP(−1)))	0.213393	0.129131	1.652533	0.1089
Δ(Ln (INV))	0.197505	0.074719	2.643296	0.0129
Δ(TBR(−1))	0.473967	0.230019	2.060555	0.0481
Δ(LR(−1))	−0.667582	0.302514	−2.206779	0.0351
Δ(PDEBT)	0.094143	0.036186	2.601604	0.0143
Δ(PDEBTSQ)	−0.001586	0.000477	−3.320048	0.0024
Δ(LITR(−2))	1.870142	0.803318	2.328022	0.0268
Δ(TFP(−1))	0.507201	0.539426	0.940261	0.3546
ECM(−1)	−0.140180	0.064869	−2.160958	0.0388
R^2	0.657426	F-statistic	5.757224	
Adjusted R^2	0.543234	Durbin–Watson stat	2.155828	
AIC	0.309619	SIC	0.769358	
DTP	29.7			

Source: Author's computation. ECM: Error correction mechanism, SE: Standard error, PCGDP: Per capita gross domestic product, TBR: Treasury bill rate, LR: Lending rate, LITR: Literacy rate, TFP: Total factor productivity, DTP: Debt turning point

4.5.1. Investment channel

The result of investment channel is presented in Table 5.

The result of investment channel as shown in Table 5 indicates that, the previous year Investment LOG (INV (-1)) impacted negatively on current investment (INV). This result is not in consonance with economic criteria. The result may be attributed to the deficit in investment in key infrastructures. Interest rate (LR) agreed with economic *apriori* expectation. The coefficient of interest rate was −0.01 indicating that, a rise in interest rate may lower investment. This result was however, not statistically significant at 5% level; implying that changes in interest rate in Nigeria did not pose a serious problem to investors within the period. The result further showed that PCGDP in the initial year was negative and significantly impacted on investment with the coefficient of −0.76 and t-statistic of −4.25. After two years, the impact of PCGDP on investment became positive and statistically significant. As PCGDP increased by 10% in the second year, investment increased by about 6.9%.

Public debt/GDP ratio was positive and statistically significant at 5% level. The result revealed that, a 10% increase in debt/GDP led to about 0.06% increase in investment, while the square of Public debt/GDP was significantly negative at a very low coefficient of about 0.00072. The result also met the *apriori* expectations. The implication of this result is that, public debt at a moderate level would enhance investment generation but when debt becomes very high would crowd out investment and erode the positive impact on investment. Debt service was positive and not statistically significant. This means that debt service in Nigeria is not very adequate in order to boost investor's confidence. If a Country is able to service her debt adequately, this would enhance investor's confidence and encourage investors to commit their resources into the economy.

The value of the ECM (−0.65) was correctly signed and statistically significant at 5% level. It indicated that, about 65% disequilibrium in the short run was adjusted in the long run. The speed of adjustment was very fast which is good for policy. adjusted $R^2 = 0.58$ indicates that about 58% changes in investment was explained by the model while the remaining 42% could be attributed to other factors not captured in the model and are taken care of by the error term. F = 7.92 showed that the variables were jointly statistically significant. D-Watson statistic (2.3) indicated no autocorrelation.

Very important in this result is the fact that, public debt variables (PDEBT, PDEBTSQ) passed the economic a *priori* expectation test and statistical significance, therefore, we conclude that investment is a transmission channel through which public debt can impact on economic growth. The implication is that, as public debt continues to rise in Nigeria without a corresponding increase in the investment climate, investors would be discouraged thereby adversely affecting economic growth.

4.5.2. Interest rate channel

Table 6 shows that, previous year interest rate LR (−1) impacted significantly on the current interest rate. Increase in the previous year interest rate by 10% resulted to a fall in the current interest rate by about 6%. Very high interest rate could result to apathy in the level of borrowing and discourage investment which in turn may cause the interest rate to fall. Previous year inflation INF (-1) positively and significantly impacted on interest rate as a 10% rise in general price resulted to about 0.05% rise in interest rate. On the other hand the second year inflation lagged was negative and also statistically significant at 5% level.

The results also suggested that a 10% increase in money supply would lead to about 4.2% decrease in interest rate. This result agrees with economic *apriori* criteria. Money supply assumed to be exogenously determined by the monetary authority and that the more the supply of money, the more interest rates reduces. Debt to GDP and debt square to GDP ratio had the values of 0.0175 and −0.00013. It is also deduced from Table 6 that increased in PCGDP reduced interest rate. Error correction term was −0.049 and statistically significant at 5% level. Disequilibrium correction was very slow at about 4% while adjusted $R^2 = 0.57$ indicates 57% explanatory power of the model. F = 6.4, D-Watson statistic was 2.1 and DTP was 65.6. The result suggests that interest rate is one of the debt transmission channels in Nigeria.

Table 5: Results for investment channel (investment is the dependent variable)

Variable	Coefficient	SE	t-statistic	P
C	0.996813	1.003031	0.993801	0.3278
Δ(Ln (INV(−1))	−0.565879	0.115187	−4.912681	0.0000
Δ(LR(−1))	−0.014588	0.008087	−1.803948	0.0774
Δ(Ln (PCGDP)	−0.767964	0.180494	−4.254785	0.0002
Δ(Ln (PCGDP(−2)))	0.692847	0.168980	4.100185	0.0003
Δ(PDEBT(−3))	0.068981	0.023022	2.996269	0.0052
Δ (PDEBTSQ(−3))	−0.000720	0.000244	−2.949040	0.0059
Δ (DSERV)	0.124520	0.068108	1.828269	0.0768
ECM(−1)	−0.656723	0.243314	−2.699076	0.0110
R^2	0.664486			
Adjusted R^2	0.580608			
F-statistic	7.922015	Durbin–Watson stat	2.331273	
AIC	1.311972			
SIC	1.688122			
DTP	47.90			

Source: Author's computation. ECM: Error correction mechanism, SE: Standard error, PCGDP: Per capita gross domestic product, TBR: Treasury bill rate, LR: Lending rate, LITR: Literacy rate, TFP: Total factor productivity, DTP: Debt turning point

4.5.3. Result of the savings channel

From Table 7, the result of the savings channel shows that, interest rate was positive but was not statistically significant. This result may imply that interest rate policy in Nigeria is yet to encourage adequate savings. Public debt/GDP ratio had a positive coefficient of 0.022 while Public debt/GDP squared had a negative coefficient (−0.00023) and were both statistically significant at 5% level giving their P = 0.0154 and 0.0160 respectively. The positive and negative impact of public debt variables agrees with the findings of Cordella et al. (2004). The implication of the result is that public debt can transmits its impact on economic growth through the saving channel.

The result also suggests that, the ECM adjusted slowly to its steady state with about 0.8% speed and was statistically significant. Adjusted R^2 = 0.81 implies that about 81% changes in savings were explained by lag of savings, interest rate, per capita income, public debt/GDP ratio and FDI. F-statistic was high showing joint significance of all the variables in the model. D-Watson statistic of 1.942 falls within the inconclusive region and therefore cannot establish the presence of autocorrelation in the model.

4.6. Discussion of Results and Implication for Policy

The study was carried out with the aim of examining the nature of relationship and effect of public debt on economic growth and the channels through which public debt impact on economic growth in Nigeria. The result of the growth equation which specified the relationship between public debt and economic growth showed that public debt at a certain stage affects economic growth positively while beyond that stage the impact on economic growth becomes negative; proving the existence of nonlinearity in their relationship. This result is in line with studies like Cordella et al. (2005). The findings also agrees with that of Checherita and Rother (2012) whose studies suggest that government debt to GDP ratio had a negative impact on long term growth, though in their own case with a turning point of 70-80%, While our result indicated DTP of 29.7% GDP ratio for Nigeria. The result also suggests that investment contributed positively to the growth of real PCGDP. However, its contribution had been trivial, which may be due to the fact that the government of Nigeria still need to inject more resources into investment purposes and also put in place investment friendly policies and programmes to create opportunities for investors.

Table 6: ECM result for interest rate (LR) channel (dependent variable is interest rate)

Variable	Coefficient	SE	t-statistic	P
C	0.042480	0.057704	0.736165	0.4673
Δ(LR(−1))	−0.985120	0.143824	−6.849493	0.0000
Δ(INF)	0.004580	0.001799	2.545629	0.0163
Δ(INF(−1))	0.005254	0.001583	3.318734	0.0024
Δ(Ln (M2(−1)))	−0.423028	0.206209	−2.051455	0.0490
Δ(Ln (M2(−2)))	0.595381	0.219405	2.713618	0.0109
Δ(PDEBT(−1))	0.017592	0.007743	2.272102	0.0304
Δ(PDEBTSQ(−1))	−0.000134	7.69E−05	−1.743600	0.0915
Δ(Ln (PCGDP(−2)))	−0.159162	0.069471	−2.291059	0.0292
Δ(Ln (PCGDP(−3)))	−0.174588	0.070307	−2.483213	0.0188
ECM(−1)	−0.049431	0.009560	−5.170446	0.0000
R^2	0.680643			
Adjusted R^2	0.574190			
F-statistic	6.393862	Durbin−Watson stat	2.111643	
AIC	−0.761233			
SIC	−0.593822			

Source: Author's computation. ECM: Error correction mechanism, SE: Standard error, PCGDP: Per capita gross domestic product, TBR: Treasury bill rate, LR: Lending rate, LITR: Literacy rate, TFP: Total factor productivity, DTP: Debt turning point

Table 7: Results for savings channel (dependent variable is savings)

Variable	Coefficient	SE	t-statistic	P
C	−0.033676	0.296838	−0.113448	0.9104
Δ(Ln (SAV(−1))	1.312250	0.115809	11.33114	0.0000
Δ(LR(−1))	0.009730	0.007045	1.381178	0.1768
Δ(Ln (PCGDP)	−0.171100	0.062573	−2.734385	0.0101
Δ(Ln (PCGDP(−3))	0.099613	0.043980	2.264927	0.0304
Δ(PDEBT(−3))	0.022039	0.008607	2.560607	0.0154
Δ(PDEBTSQ(−3))	−0.000231	9.08E−05	−2.544059	0.0160
Δ(FDI)	0.026330	0.011865	2.219074	0.0337
ECM(−1)	−0.084104	0.015426	−5.452028	0.0000
R^2	0.848995			
Adjusted R^2	0.811244			
F-statistic	22.48919	Durbin–Watson stat		1.842301
AIC	−0.631456			
SIC	−0.255306			
DTP	47.7			

Source: Author's computation. ECM: Error correction mechanism, SE: Standard error, PCGDP: Per capita gross domestic product, TBR: Treasury bill rate, LR: Lending rate, LITR: Literacy rate, TFP: Total factor productivity, DTP: Debt turning point, FDI: Foreign direct investment

Public debt to GDP ratio had a positive and significant impact on investment, interest rate and private savings in Nigeria. In the same vein, public debt to GDP squared impacted negatively on investment, interest rate and savings. This indicates that if public debt is channeled to investment purposes it will boost investment which will also increase economic growth and when debt is very high its impact on investment would also be negative. Debt and investment relationship in this regards is inverted U-shaped. This result is in contrast with the finding of Apere (2013) whose external debt investment relationship was U-shaped.

The result also shows that public debt has an inverse relationship with interest rate and savings. This is indicated in the negative correlation of public debt with interest rate. Crowding out of private investment is induced by changing interest rate and higher debt leading to increase in interest rate, therefore debt accumulation should be kept low to avoid interest rates variability that may lead to a fall in real output.

5. CONCLUSIONS

The study evaluated the nonlinear impact of public debt on economic growth and the channels on which public debt impact on growth. The study concludes that the relationship between public debt and economic growth in Nigeria is non-linear. Public debt at different levels affects economic growth differently. Low debt stock impacted positively and significantly on economic growth but high public debt resulted to a reverse significant impact on growth. That accumulation of debt for development purposes is not harmful within 29.7% debt GDP ratio but beyond this threshold, further debt accumulation will result to a negative growth in Nigeria. The result of the evaluation of the channels through which public debt transmit its negative impact on economic growth also showed that public debt also have positive impact on investment at a lower debt GDP ratio and a reverse impact as debt grew above a certain ratio. This also confirms the nonlinearity of public debt investment relationship hence investment is considered a debt transmission channel in Nigeria. The variability and wide gap between debt growth and investment growth is an indication that public debt is not channeled adequately to investment purposes.

In as much as savings, investment and interest rates are the debt transmission channels, it is important that there should be a harmonious coordination of monetary and fiscal policy that will ensure a stable economic growth in Nigeria.

6. RECOMMENDATIONS

The nonlinear impact of public debt on growth is an indication that debt level is important for policy. The implication is that lower level of debt enhances economic growth. When public debt accumulation becomes so high that it is no longer tolerable, its impact will result to the plummeting of economic growth. Hence, the study recommended that Nigerian governments should to take cognizance of existing debt level before contracting new loans so as not to exceed the debt carrying capacity that may hamper economic growth.

Furthermore, the positive impact of investment on economic growth calls for increase in both public and private investment in the productive sectors of the economy in order to boost economic growth in Nigeria. This can be realized if government can channel borrowed funds into investments. Interest rate should be raised when public debt increases above the debt sustainability threshold, this will discourage government from borrowing continuously and reduce the impending negative effect on economic growth.

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