A Residual-Based Cointegration and Causality Analysis of Population Growth and Real Output in Nigeria

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***Abstract*:- This study investigates the relationship between population growth and real output in Nigeria. The study uses annual population and real GDP log transformed time series data from 1960 to 2015 and employs Augmented Dickey-Fuller and Phillips-Perron unit root tests, Pearson Moment correlation coefficient, OLS, Engle-Granger and Phillips-Ouliaris residual based cointegration tests, as well as pair-wise Granger causality test. Our results revealed that the variables under study are integrated of order one. The study found positive and significant correlation between population growth and real GDP. Population growth is also found as having positive and significant impact on real output. However, the study found no statistical evidence in support of the existence of long-run stable relationship between population growth and real GDP in Nigeria. Also, our results found no statistical evidence of the causal relationship between population growth and real GDP in Nigeria. We therefore conclude that, although population growth has significant impact on real output in Nigeria, it does not in any way Granger causes real output (real GDP) and vice versa. This result seems to be reasonable because some countries have experienced higher output and economic development even with a smaller population while others like Nigeria experienced lower output and economic growth even with a larger population.**

***Keywords:* Population, Real Output, Correlation, Cointegration, Granger Causality, Nigeria.**

I. INTRODUCTION

Population is defined as the total number of people living in a particular geographical area or region and is capable of interbreeding. Population growth refers to an increase in size of the population of a particular region or country. Population growth of a country occurs only when the total birth rate or fertility rate of that country exceeds the total death rate or mortality rate. This means that more live births occur in the country than deaths thereby making the population to go up. Population can also increase if the total number of emigrants of the country is higher than the total number of immigrants of the same country. This means that more people are entering the country which increases the overall population of the country. Population growth has many benefits as well as problems.

High population provides high labour force. If the high lobour force engages in productive activities the nation will eventually got high growth rate. A typical example is China who uses her high labour force in productive process and has gotten tremendous growth which made the economy to be so strong and developed. Here in Nigeria the problem associated with high labour force is unemployment rate. It was about 3.11% in 1970, 13.1% in 2000 and about 23.9%% in 2011. When population grows faster than GNP, the standard of living of the people does not improve. In fact rapid population growth has been obstructing economic growth in developing countries like Nigeria where since 1960 population has been growing at a relatively high rate.

A higher population growth is a major concern in Nigeria and a challenge to the countrys' economy. The population of Nigeria was about 45 million in 1960 and rose to about 140 million in 2006 (2006 population census). Based on the latest United Nations estimates, the current population of Nigeria is about 187 000 000 as of July, 2016 with an annual growth rate of 4.27%. Nigeria population is equivalent to 2.48% of the total world population and is ranked 7th in the list of countries by population.

Economic growth is a measure of expansion of the economy over time. It is a measure of the annual growth and expansion in size of the economy or a measure of the relative economic strength/power of a country. Gross Domestic Product (GDP), is a measurement of the annual productivity of the property and labour of all citizens and foreign residents within the geographic borders of a country including its foreign territories such as embassies and purchased military bases abroad. When GDP is divided by the GDP deflator index and multiply by 100 the result is called *real* GDP. Whenever there is increase in real GDP of a country it boosts the overall output and we called it economic growth. The economic growth is helpful to increase the incomes of the society, help the nation to bring the unemployment at low level and also helpful in the deliveries of public services. Over the last few decades population growth and economic growth relationship became the hot issue amongst researchers, (Ullah and Rauf 2013).

A vast body of knowledge concerning the relationship between population growth and economic growth exists in the literature. However, whether a positive or negative relationship exists between the two variables is still unfolding. Nam (1994) asserts that "no firm statements can be made about the relationship between population growth and economic development as different countries have different experiences in this regard i.e. what is true for one country might not be suitable for another country as its population growth pattern and economic structure might be different". In conformity to Nam's assertion; Dullah *et al.* (2011) investigated the empirical relationship between population growth and economic growth in Malaysia using cointegration and causality analysis. Their findings did not support the existence of long-run relationship between population growth and economic growth. Also they found no statistical evidence of causal relationship between population growth and economic growth in Malaysia. In a related development, Dawson and Tiffin (1998) analyzed the long-run relationship between population change and economic growth in India using annual time series data from 1950-1993. The study employed cointegration and Granger causality techniques and found no long-run relationship between population growth and economic growth. They also found that population growth neither Granger causes economic growth nor is caused by it. By employing the same methods of analysis Thornton (2001) found similar results by conducting a similar research using similar variables in seven Latin American countries, namely, Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela using annual time series data for the period 1900-1994. No single long-run relationship between the two variables was found between any of the seven countries. Furthermore, no unidirectional or feedback causality between population growth and economic growth was observed.

By investigating the relationship between population growth and economic development (GDP) using Engle-Granger and Johansen cointegration tests, Furuoka (2005) found a long-run cointegration relationship between population growth and GDP and a bidirectional causality between the two variables in the short-run in Malaysia. In another study conducted by Tsen and Furuoka (2005) on the relationship between population growth and economic growth in Asian countries including Malaysia, no cointegration relationship was found between economic growth and population in Malaysia. However, economic growth was found to Granger caused population growth. Thuku *et al.* (2013) conducted a study to establish a relationship between economic growth and population growth in Kenya using Vector Auto Regressive estimation technique and annual time series data from 1963 to 2009. They found a positive correlation between population growth and economic growth and that population growth had positive impact on economic growth in Kenya. The study concluded that population growth promotes economic growth and economic development in Kenya.

Ali *et al.* (2013) empirically tested the impact of Population growth on Economic Development in Pakistan for period of 1975-2008 using ARDL technique. The result of the model shows that population growth has positive and significant impact on economic development in Pakistan but is negatively affected by unemployment rate. Afzal (2009) examined the impact of population growth on economic growth in Pakistan using annual time series data for the period 1951 to 2001. He employed OLS estimation technique and found that population growth had negative impact on economic development in Pakistan. He considered population growth as a real problem hindering economic development in Pakistan. Mamingi and Perch (2013) examined the nature of the relationship between population growth and economic growth/development in Barbados for the period 1980-2010 using Autoregressive Distributed Lag approach to cointegration. Their study found that population growth and population density have positive and significant impact on economic growth; economic growth had negative and significant impact on population growth; the rate of natural increase positively and significantly affects population growth; while net international migration had negative and significant impact on population growth. Mahmud (2015) employed Johansen Cointegration Test and Vector Error Correction Model and Granger causality test to examine the relationship between population growth and economic growth in India using time series data from 180 to 2013.The study found a positive and significant relationship between population growth and economic growth and a unidirectional causality running from economic growth to population growth.

In Nigeria many researchers investigated empirically the relationship between population growth and economic growth using different analytical tools and different data sets with almost similar results. For example, Adewole (2012) examined the effect of population on economic development in Nigeria using regression analysis and annual time series data from 1981 to 2007. He found population growth as having positive and significant impact on real gross domestic product (RGDP) and per capita income (PCI). Ukpong *et al.* (2013) used Engle-Granger and Johansen cointegration tests as well as OLS to explore the relationship among poverty rate, population growth and real gross domestic product (GDP) in Nigeria. The results show that the variables were cointegrated; with a positive relationship between poverty rate and population growth, and negative relationship between GDP real growth rate and poverty rate in Nigeria.

Nwosu *et al.* (2014) conducted a study to investigate the effect of population growth on economic growth in Nigeria and how economic growth is effected through population growth.

The study used annual secondary time series data spanning from 1960 to 2008. They employed OLS, cointegration and Granger Causality techniques and found that population growth has positive and significant impact on economic growth in Nigeria. The study also found a long-run equilibrium relationship between economic growth and population growth and a unidirectional causality between population growth and economic growth in Nigeria. Tartiyus *et al.* (2015) evaluated the impact of population growth on economic growth in Nigeria from 1980-2010. They employed descriptive statistics and regression analysis as analytical tools and found a positive relationship between economic growth and population, fertility and export growth; while negative relationships were found between economic growth and life expectancy, and crude death rate.

From the above reviewed literature, it is glaring to know that while different researchers across different countries employed different analytical tools to investigate the relationship between population growth and economic growth, many agreed that population growth has positive impact on economic growth whereas others disagreed. The issue of long-run equilibrium relationship and Granger causality between population growth and economic growth are greatly controversial in the literature. This study uses sophisticated statistical tools to re-examine the relationship between population growth and real output taking Nigeria as a case study using more recent data.

II. MATERIALS AND METHODS

2.1 Data and Source

The data used in this study are annual population and real GDP time series data from 1960 to 2015 obtained as secondary data from www.factfish.com. The collected data was transformed to natural logarithm before analysis.

2.2 Augmented Dickey-Fuller (ADF) Unit Root Test

Let $\{Y_t\}$ be a given time series, the ADF unit root test is used to check whether the given series contains a unit root or whether the given series is stationary or not, Dickey and Fuller (1979). The Augmented Dickey-Fuller (ADF) test constructs a parametric correction for higher-order correlation by assuming that the series follows an AR(p) process and adding lagged difference terms of the dependent variable to the right-hand side of the test regression:

$$\Delta Y_t = \alpha Y_{t-1} + X_t^{'}\delta + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \cdots + \beta_p \Delta Y_{t-p} + \varepsilon_t \qquad (1)$$

where X_t are optional exogenous regressors which may consist of constant, or a constant and trend, α and δ are parameters to be estimated, and the ε_t are assumed to be white noise. The null and alternative hypotheses are written as:

$$H_0: \alpha = 0 \text{ vs } H_1: \alpha < 0 \qquad (2)$$

and evaluated using the conventional t −ratio for α:

$$t_\alpha = \hat{\alpha}/\{\text{se}(\hat{\alpha})\} \qquad (3)$$

where $\hat{\alpha}$ is the estimate of α, and $\text{se}(\hat{\alpha})$ is the coefficient standard error.

2.3 The Phillips-Perron (PP) Unit Root Test

Phillips and Perron (1988) propose an alternative non-parametric method of controlling for serial correlation when testing for a unit root. The PP method estimates the non-augmented DF test equation

$$\Delta Y_t = \alpha Y_{t-1} + X_t^{'}\delta + \varepsilon_t \qquad (4)$$

and modifies the t −ratio of the α coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. The PP test is based on the statistic:

$$\tilde{t}_\alpha = t_\alpha \left(\frac{\psi_0}{\phi_0}\right)^{1/2} - \frac{T(\phi_0 - \psi_0)(se(\hat{\alpha}))}{2\phi_0^{1/2}s} \qquad (5)$$

Where $\hat{\alpha}$ is the estimate, and t_α the t −ratio of $\alpha, se(\hat{\alpha})$ is coefficient standard error, and s is the standard error of the test regression, ψ_0 is a consistent estimate of the error variance in (4) which is calculated as $(T-k)s^2/T$, where k is the number of regressors and ϕ_0 is an estimator of the residual spectrum at frequency zero.

2.4 Pearson Moment Correlation Coefficient

To examine the degree and direction of association between population growth and real output, we employ Pearson Moment correlation coefficient (r). The correlation coefficient of x on y (r_{xy}) is given by:

$$r = \frac{Cov(x,y)}{\sigma_x \sigma_y} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \qquad (6)$$

where $-1 < r < 1$, a positive value of r indicates a positive relationship while a negative value of r indicates a negative relationship between x and y.

2.5 Linear Regression Model Specification

To examine the impact of population growth on real output in Nigeria, we specify our linear regression model as follows:

$$RGDP_t = \beta_0 + \beta_1 POP_t + \varepsilon_t \qquad (7)$$

Since real GDP and population have different units of measurement, we transform the variables to natural logarithm and re-specify our model as follows:

$$\ln RGDP_t = \beta_0 + \beta_1 \ln POP_t + \varepsilon_t \qquad (8)$$

Where RGDP is real gross domestic product used as proxy for real output, POP is the population change used as proxy for population growth, β_0 is the intercept of the regression line, β_1 is the slope coefficient of the independent variable and ε_t is the error term which accounts for unexplained variations in the regression model. Theory expects β_1 to be positive and significant for population to have positive impact on real output.

2.6 Engle-Granger Residual-based Cointegration Test

Engle and Granger (1987) noted that a linear combination of two or more I(1) series may be stationary, or I(0), in which case we say the series are cointegrated. Such a linear combination defines a cointegrating equation with cointegrating vector of weights characterizing the long-run relationship between the variables. The Engle-Granger residual-based test for cointegration is simply unit root tests applied to the residuals obtained from SOLS estimation of the following equation:

$$Y_t = X_t^{'}\beta + D_{1t}^{'}\gamma_1 + u_{1t} \quad (9)$$

where $D_t = (D_{1t}^{'}, D_{2t}^{'})^{'}$ are deterministic trend regressors and the n stochastic regressors X_t are governed by the system of equations:

$$X_t = \Gamma_{21}^{'} D_{1t} + \Gamma_{22}^{'} D_{2t} + \varepsilon_{2t};\ \Delta\varepsilon_{2t} = u_{2t} \quad (10)$$

Under the assumption that the series are not cointegrated, all linear combinations of $(Y_t, X_t^{'})$, including the residuals from SOLS, are unit root nonstationary. Therefore, a test of the null hypothesis of no cointegration against the alternative of cointegration corresponds to a unit root test of the null of nonstationarity against the alternative of stationarity.

The Engle-Granger test uses a parametric, augmented Dickey-Fuller (ADF) approach. The Engle-Granger test estimates a p −lag augmented regression of the form:

$$\Delta\hat{u}_{1t} = (\rho - 1)\hat{u}_{1t-1} + \sum_{j=1}^{p} \delta_j \Delta\hat{u}_{1t-j} + v_t \quad (11)$$

The number of lagged differences p should increase to infinity with the (zero-lag) sample size T but at a rate slower than $T^{1/3}$. The Engle-Granger consider two standard ADF test statistics, one based on the t −statistic for testing the null hypothesis of nonstationarity ($\rho = 1$) and the other based directly on the normalized autocorrelation coefficient $\hat{\rho} = 1$:

$$\left.\begin{aligned} \hat{\tau} &= \frac{\hat{\rho} = 1}{se(\hat{\rho})} \\ \hat{z} &= \frac{T(\hat{\rho} = 1)}{(1 - \sum_j \hat{\delta}_j)} \end{aligned}\right\} \quad (12)$$

Where $se(\hat{\rho})$ is the usual OLS estimator of the standard error of the estimated $\hat{\rho}$

$$se(\hat{\rho}) = \hat{s}_v \left(\sum_t \hat{u}_{1t-1}^2\right)^{-1/2} \quad (13)$$

(Stock, 1986; Hayashi, 2000). The Engle-Granger cointegration test uses the degree of freedom corrected estimated standard error $\hat{s}_v$, with an option of not including the correction.

2.7 Phillips-Ouliaris Cointegration Test

The Phillips-Ouliaris residual based cointegration test obtains an estimate of ρ by running the unaugmented Dickey-Fuller regression:

$$\Delta\hat{u}_{1t} = (\hat{\rho} - 1)\hat{u}_{1t-1} + \omega_t \quad (14)$$

and using the results to compute estimates of the long-run variance ω_w and the strict one-sided long-run variance λ_{1w} of the residuals. The bias corrected autocorrelation coefficient of Phillips-Ouliaris cointegration test is then given by:

$$(\hat{\rho}^* - 1) = (\hat{\rho} - 1) - T\hat{\lambda}_{1w}\left(\sum_t \hat{u}_{1t-1}^2\right)^{-1} \quad (15)$$

and the corresponding test statistics are given by:

$$\left.\begin{aligned} \hat{\tau} &= \frac{(\hat{\rho}^* - 1)}{se(\hat{\rho}^*)} \\ \hat{z} &= T(\hat{\rho}^* - 1) \end{aligned}\right\} \quad (16)$$

$$\text{where } se(\hat{\rho}^*) = \hat{\omega}^{1/2}{}_w \left(\sum_t \hat{u}_{1t-1}^2\right)^{-1/2} \quad (17)$$

Just like ADF and PP statistics, the asymptotic distributions of the Engle-Granger and Phillips-Ouliaris z and τ statistics are non-standard and depend on the deterministic regressors specification, so that critical values for the statistics are obtained from simulation results.

2.8 Granger Causality Test

To investigate the direction of causality between population growth and real GDP, we employ Granger causality test. The Granger (1969) approach to the question of whether population growth causes real output is to see how much of the current real output can be explained by past values of real output and then to see whether adding lagged values of population growth can improve the explanation.

$Real\ GDP$ is said to be Granger-caused by $Population\ growth$ if $population\ growth$ helps in the prediction of $real\ GDP$, or equivalently if the coefficients on the lagged $population\ growth$'s are statistically significant. If $population\ growth$ Granger causes $real\ GDP$ and $real\ GDP$ in turn Granger causes $population\ growth$, then we say that the causality is two-way or bidirectional. It is important to note that the statement "$population\ growth$ Granger causes $real\ GDP$" does not imply that $real\ GDP$ is the effect or the result of $population\ growth$. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. Consider bivariate regressions of the form:

$$RGDP_t = \alpha_0 + \alpha_1 RGDP_{t-1} + \cdots + \alpha_l RGDP_{t-l} + \beta_1 POP_{t-1} + \cdots + \beta_l POP_{-l} + \varepsilon_t \quad (18)$$

$$POP_t = \alpha_0 + \alpha_1 POP_{t-1} + \cdots + \alpha_l POP_{t-l} + \beta_1 RGDP_{t-1} + \cdots + \beta_l RGDP_{-l} + u_t \quad (19)$$

For all possible pairs of $(POP, RGDP)$ series in the group. The reported F-statistics are the wald statistics for the joint hypothesis:

$$\beta_1 = \beta_2 = \cdots = \beta_l = 0 \quad (20)$$

For each equation, the hypothesis is that POP does not Granger cause $RGDP$ in the first regression and that $RGDP$ does not Granger cause POP in the second regression. In each case, a rejection of H_0 implies there is Granger causality.

III. RESULTS AND DISCUSSION OF EMPIRICAL FINDINGS

3.1 Unit Root and Stationarity Test Results

To check whether the study variables contain a unit root and to determine the order of integration of the series, we employ Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The results of the tests are presented in Table 1.

Table 1: ADF and PP Unit Root Test Results

Variable	Option	ADF Unit Root Test		PP Unit Root Test	
		ADF Test stat.	P-value	PP Adj.t-stat.	P-value
$\ln rgdp$	Intercept only	0.081619	0.9615	0.081619	0.9615
	Intercept & trend	-1.133886	0.9136	-1.163316	0.9080
$\Delta \ln rgdp$	Intercept only	-7.268734	0.0000**	-7.168336	0.0000**
	Intercept & trend	-7.158913	0.0000**	-7.158944	0.0000**
$\ln pop$	Intercept only	-0.180872	0.9335	1.806697	0.9997
	Intercept & trend	-1.853859	0.1807	-3.227042	0.0899
$\Delta \ln pop$	Intercept only	-9.058886	0.0000**	-7.861908	0.0001**
	Intercept & trend	-8.761285	0.0000**	-9.516251	0.0000**

Note: ** denotes the rejection of null hypothesis of the ADF and PP tests at 1% marginal significance level.

The ADF and PP unit root test results indicate that the variables under study are non-stationary (contain unit roots) in levels. This is clearly shown by the insignificant p-values of the ADF and PP test statistics. However, the ADF and PP unit root tests applied on the first differences of the series indicate that the variables are stationary (do not contain unit roots) in their first differences. This is clearly shown by the highly statistical significant p-values of the ADF and PP test statistics. Stationarity in the first difference means that there is an approximate level of linear growth in the series. We therefore conclude that the study variables are integrated of order one, I(1).

3.2 Pearson Moment Correlation Result

Having known the order of integration of the study variables which is vital for cointegration test, we first conduct pearson moment correlation test on the study variables to determine the level and direction of association between population growth and real GDP. The result is presented in Table 2.

Table 2: Pearson Correlation Coefficient of Real Output and Population Growth in Nigeria

Pearson Correlation Coefficient	Value	P-value
r	0.891	0.0000**

Note: **Correlation is significant at the 0.01 level (2-tailed).

The Pearson moment correlation coefficient result shows that population growth and real GDP in Nigeria are strongly and significantly positively correlated. This means that both variables move in tandem. That is, as the population of Nigeria increases her real GDP also increases and vice versa. This result collaborates the finding of Thuku *et al.* (2013) who also found positive correlation between population growth and economic growth in Kenya.

3.3 Linear Regression Result

Having known the degree of association of the study variables, we now investigate the long-term relationship and the impact of population growth on real output in Nigeria. The result is reported in Table 3.

Table 3: Regression Results of Real Output (RGDP) and Population Growth

Dependent Variable: lnRGDP		Method: Ordinary Least Squares		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-27.54635	3.584495	-7.684864	0.0000
lnPOP	2.830685	0.195751	14.46061	0.0000
R-squared	0.794762	F-statistic	209.1093	
Adjusted R-squared	0.790961	Prob(F-statistic)	0.000000	
Durbin-Watson stat	0.152155			

The result of our regression model reveals that population growth has positive and significant impact on real gross domestic product (RGDP). This means that for every unit increase in population, real GDP is predicted to increase by 2.830685 units in log form. The intercept of the regression model is negatively related to real output. This means that real GDP is predicted to be less than zero if the total population is kept constant. Both the intercept and the slope coefficient of population growth are found statistically significant based on the t-statistic and F-statistic results.

The R-squared which is the coefficient of determination of the regression model shows that about 79.48% of the total variations in the real output has been explained by population growth. The 20.52% unexplained variations are being accounted for by the error term or by factors not included in the model. The F-statistic which is a goodness-of-fit test that measures the overall significant of the regression model is found to be highly statistically significant at 1% marginal significance level. This shows that our regression model is a good fit. The goodness of fit of the regression model still remained high even after adjusting for degree of freedom since R-squared adjusted is 79.10%.

The Durbin-Watson statistic value of 0.152155 which is less than R^2 and adjusted R-squared gives strong support for the presence of positive serial correlation in the residuals of the estimated regression equation which might cause the estimated parameters to be bias and inconsistent. This result agrees with the findings of Adewole (2012), Mamingi and Perch (2013), Ali *et al.* (2013), Thuku *et al.* (2013), Nwosu *et al.* (2014), Mahmud (2015) and Tartiyus *et al*. (2015) among others. However, this result contradicts the findings of Afzal (2009) who found negative impact of population growth on economic development in Pakistan.

3.4 Residual-Based Cointegration Test Results

Since the study variables have the same order of integration, we are now in the better position to explore the long-run relationship between population growth and real GDP. In doing this, we employ Engle-Granger and Phillips-Ouliaris residual-based cointegration tests. The results are presented in Table 4.

Table 4: Engle-Granger & Phillips-Ouliaris Residual Based Cointegration Test Results

Test	Value	P-value*
Engle-Granger tau-statistic	-1.306822	0.8296
Engle-Granger z-statistic	-3.342633	0.8533
Phillips-Ouliaris tau-statistic	-1.404647	0.7983
Phillips-Ouliaris z-statistic	-3.810557	0.8189

Note: * denotes MacKinnon (1996) p-values.

Both the Engle-Granger and Phillips-Ouliaris tau-statistic (t-statistic) and z-statistic fail to reject the null hypotheses of no cointegration (unit root in the residuals) at the 1% marginal significance level. The test evidence clearly shows that population growth and real GDP (real output) are not cointegrated. The tests clearly denied the existence long-run relationship between population growth and real GDP in Nigeria. This result is in conformity with the findings of Dawson and Tiffin (1998), Tsen and Furuoka (2005), Thornton (2001) and Dullah *et al.* (2011) among others, however, it disagrees with the findings of Furuoka (2005).

3.5 Pair-wise Granger Causality Test Results

This section looked at the direction of causality between population growth and real GDP. This becomes necessary due to the strong contention in economic circle that in some cases an increase in one variable may lead to an increase in another variable but actually there may be no causality relationship between them. The result of pair-wise Granger causality test is presented in Table 5.

Table 5: Pair-wise Granger Causality Test Result

Null Hypothesis	F-statistic	P-value
POPULATION does not Granger Cause Real GDP	0.90926	0.4095
Real GDP does not Granger Cause POPULATION	1.01605	0.3695

The pair-wise Granger causality test result found no statistical evidence of causality between population growth and real GDP in Nigeria. Although population growth is positively correlated with real GDP and has significant impact on real output, it does not in any way Granger caused real GDP and vice versa. This result seems to be reasonable because some countries have experienced higher economic growth and development even with a smaller population while others experienced lower economic growth even with a larger population. This result agrees with the findings of Dawson and Tiffin (1989), Thornton (2001) and Dullah et al. (2011) among others.

IV. CONCLUSION

This study attempted to investigate the causal relationship between population growth and real output in Nigeria. The study used annual population and real GDP log transformed time series data from 1960 to 2015 and employed Augmented Dickey-Fuller and Phillips-Perron unit root tests to examine the unit root and stationarity properties of the data, Pearson Moment correlation coefficient was used to check the degree and direction of association between the study variables, OLS was applied to investigate the impact of population growth on real output, Engle-Granger and Phillips-Ouliaris residual based cointegration test was employed to determine the long-run equilibrium relationship between the study variables while a pair-wise Granger causality test was employed to examine the direction of causality.

Our results revealed that the variables under study are integrated of order one. The study found positive and significant correlation between population growth and real GDP. Population growth was also found as having positive and significant impact on real output. However, the study found no statistical evidence in support of the existence of long-run relationship between population growth and real GDP in Nigeria. Also, our results found no statistical evidence of the causal relationship between population growth and real GDP in Nigeria. We therefore conclude that, although population growth has significant impact on real output in Nigeria, it does not in any way Granger causes real output (real GDP) and vice versa. This result seems to be reasonable because some countries have experienced higher output and economic development even with a smaller population while others like Nigeria experienced lower output and economic growth even with a larger population.

As a policy implication of the outcome of this study, we suggest among other things that, government should take the increasing population as virtue by investing more resources in human capital development through quality education, employment provision, improved healthcare services, infrastructures as well as encouraging small and medium scale industries in order to achieve the long run economic growth.

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