Ascertaining the Optimal Population Growth Threshold for Nigeria's Economic Development

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***Abstract*: This paper sought to study the demographic dynamics in the Nigerian economy as it affects the development process of the country. The study specifically investigated the determining factors of population growth in Nigeria, along with the effect of infant mortality on fertility rate. The study employed the ordinary least squares regression and threshold regression analysis in achieving the set objectives. The data for the study were obtained from World Development Indicators and they covered the period of 1970 to 2017. The result of the study revealed that the determining factors of population growth in Nigeria are crude birth rate and infant mortality rate. Also, a positive and significant effect of infant mortality on fertility rate was observed. The optimal threshold of crude birth rate was obtained to be 41.62%, while the optimal population growth level that is sustainable for economic development was estimated to be 2.50%. The paper concluded that there is need to maintain an optimal population growth that will be consistent with the available resources is sustainable economic development is to be achieved.**

Keywords: **Population Growth; Economic Development, Demographic Transition, Threshold Regression; Fertility; Crude Birth Rate.**

I. INTRODUCTION

Population increase has a contradictory impact on a country's progress. It both aids and hinders economic progress. Population expansion was deemed bad by Greek philosophers over 2,500 years ago because it hampered economic development. Plato (427-347 B.C.) proposed that the number of residents in a kingdom be fixed at 5,040 since this number is divisible by any integer from 1 to 12 except 11. Aristotle (384-322 B.C.) reasoned in a similar manner. He wished that the country's population not reach a particular threshold. Sir William Petty (1984) provided an upbeat assessment of population increase. Adam Smith saw population increase as a source of prosperity as well. However, traditional economists, particularly T.R. Malthus (1798), raised the alarm about a country's rapid population increase.

Ehrlich (1968) and others revitalized Malthusian viewpoints on the impact of population expansion on social and economic well-being in the later part of the twentieth century, when population growth rates reached extremely high levels, mainly in low-income nations. These writers were concerned that the world's population would outstrip the earth's and its resources' ability to provide food and other necessities for human survival. Many people believed that in order to prevent an existential crisis, both population and economic development should be reduced or eliminated totally. Other writers believed that population growth worries were overstated, saying that population increase would spur technical progress, allowing food supply to keep up with the rising population (Boserup, 1965 cited in Peterson, 2017), or that more numbers of individuals would result in more minds available to solve any resource issues that may occur (Simon, 1981 cited in Peterson, 2017).

The link between population expansion and economic development may be summed up in the words of Robert McNamara, former World Bank president (Kumar, 2021). He called it "the most delicate and complex topic of our day. Above all, it is enormously intricate. In the same vein, the then Prime Minister of England, Mr. Pitt, declared in the 18th century: "A man may enrich his nation by bearing a large number of children, even if the entire family was impoverished." All of this suggests that not only is there no contradiction between population expansion and economic progress, but also population expansion is required for increased prosperity and progress. The Malthusian view, on the other hand, sees population expansion as the most significant impediment to economic development (Kumar, 2021). As a result, population increase and economic development affects each other in an opposite direction. It has the potential to be both a stimulant and a hindrance to growth and development. Such opposing responsibilities imply that the link between population and economic development is nuanced, multifaceted, and fascinating.

At the first instance, an expanding population indicates an increase in the number of working people who may participate actively in an economy's quest for economic growth and development. It follows that a growing population can also stimulate the growth of output in an economy. Secondly, a greater population equals a larger market for most goods and services. A potentially expanding market may encourage entrepreneurs to invest in capital goods and machines at an increasing rate. Thirdly, an arithmetic rise in population allows for better economies of scale in industry, more division of labour, market expansion, and so on. This made The World Bank (1984) to opined that "…there is little uncertainties that

people, and the advancement of human knowledge via people, are the keys to economic progress. Per capita income metrics should not be interpreted as implying that the denominator, individuals, contributes nothing to the numerator, total income. Moreover, population expansion is not the primary cause of natural resource issues such as air pollution, soil degradation, or food shortages" (World Development Report, 1984).

Higher population growth rates would certainly lead to higher economic growth rates if population growth and per capita GDP growth were fully independent (Peterson, 2017). It would still be true, as observed by Piketty (2014), that "only increases in per capita GDP would result in gains in economic well-being" (Peterson, 2017).Higher population growth rates, on the other hand, might contribute to either higher or lower total economic growth, depending on the nature of its impacts on per capita GDP (Peterson, 2017). Such scenarios can also be a function of the composition of the population. Growth can be achieved much when the proportion of the working population is greater than that of the aging population.

The Nigeria population and its determining factors is characterised by dynamics in its composition. Given the dynamic nature of the Nigerian population, it can be observed that there has been a dispersion in the distribution of male and female population in the country. This is presented in Figure 1.

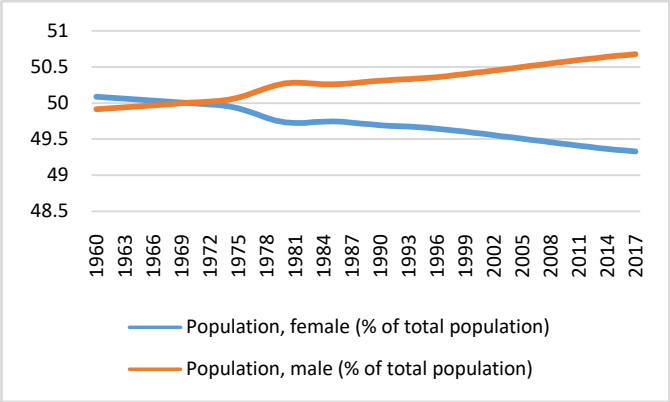

Figure 1: Distribution of Male and Female Population in Nigeria (1960 – 2017)

Given Figure 1, female population in the 1960s outweighed that of male, though quite slightly. For instance, the ratio of male to female population in 1960 was 49.91:50.50.09. This ratio declined steadily till 1969 where the ratio was approximately 50:50 as indicated by the meeting points of the two lines in Figure 1. Thereafter, the country experienced wide dispersion in the proportion of male and female population till 2017. As at 1982, the ratio was 50.28: 49.72 but increased to as high as 50.67:49.33 as at 2017.

Also, the Nigeria's population exhibited a somewhat steady average growth rate of 2.60% within the period 1970 to 2017. This behaviour is presented in Figure 2.

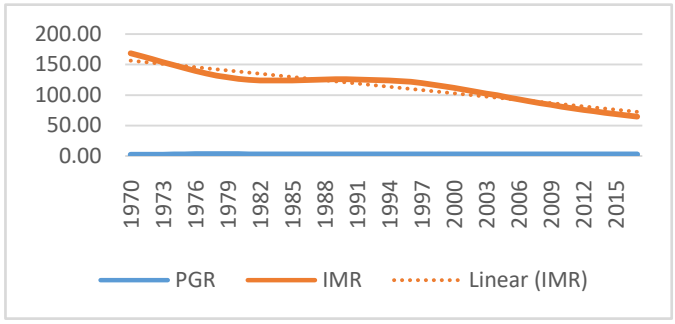

Figure 2: Trend of Population Growth and Infant Mortality Rate in Nigeria (1970 – 2017)

Meanwhile, infant mortality has been on the decline over the years. Infant mortality (Mortality rate, infant (per 1,000 live births)) as at 1970 was as high as 168.20 per 1,000 live births. This implies that out of 1,000 children being given birth to as at 1970, 168 are likely to die before their next birthday. Meanwhile, the figure was 125 per 1,000 live births as at 1981. The rate further declined to 112 per 1,000 live births as at 2000. Within 2004 to 2017, the rate remained a single-digit. For example, the rate was 84 per 1,000 live births as at 2009, and then declined to 65 per 1,000 live births as at 2017.

Other key demographic variables of interest include crude birth rate and fertility rate. The average annual behaviour of the variables is presented in Table 1 along with previously described variables but this time in their annual average.

Table 1: Average Annual Growth Rate Of Population, Growth Rate Of GDP Per Capita, Birth Rate, Fertility Rate, And Infant Mortality Rate

year	Population Growth	Growth Rate of GDP Per Capita	Crude Birth Rate	Fertility Rate	Infant Mortality Rate
1970 - 1974	2.39	11.83	46.75	6.57	158.50
1975 - 1979	2.92	2.17	47.22	6.75	135.92
1980 - 1984	2.64	-5.55	46.48	6.76	124.48
1985 - 1989	2.61	3.69	45.09	6.62	124.90
1990 - 1994	2.53	2.58	43.88	6.4	124.88
1995 - 1999	2.49	2.05	43.31	6.19	119.08
2000 - 2004	2.53	8.57	42.96	6.06	105.54
2005 - 2009	2.63	6.78	42.09	5.93	89.96
2010 - 2014	2.67	6.1	40.63	5.75	75.86
2015 - 2017	2.63	0.61	38.89	5.52	66.63

Source: World Development Indicators

Population growth averaged 2.39% within 1970 to 1974 and then increased to 2.92% within 1975 to 1979. Similarly, the growth rate of GDP per capita averaged a record high of 11.83% within the period 1970 to 1974 but declined drastically to an average of 2.17% within 1975 to 1979. The growth rate of the Nigerian population seems to hover much within the 2.5% and 2.6% limit but such is still being characterised by an outlier such as 2.39% within 1970 to 1974.The Nigerian economy witnessed an average of -5.55% growth in GDP per capita within 1980 to 1984, but later

recovered in the preceding period. For example, it averaged 3.69% within 1985 to 1989; 8.57% within 2000 to 20004; and 0.61% within 2015 and 2017.

The country is also being characterised by a declining crude birth rate over the period under review. For instance, crude birth rate averaged 47.22% within 1975 to 1979; declined to 43.88% within 1990 to 1994; further declined to 42.09% within 2005 and 2009; and then to 38.89% within 2015 and 2017. This decline in birth rate was not characterised by a declining population growth as observed in the table.

It is worth noting that there has been a declining behaviour in average fertility rate in the country from 1980 to 2017. Within 1980 and 1984, fertility rate averaged 6.76% but declined to 6.19% within 1995 and 1999. As at within 2010 to 2014 and 2015 to 2017, fertility rates averaged 5.75% and 5.52% respectively. This was followed by a continuous decline in infant mortality rate over the review period.

Given the behaviour of the demographic variables, it can therefore seem necessary to ponder on key questions. These are:

i. What are the determinants of population growth in Nigeria?
ii. What is the effect of mortality rate on fertility rate in Nigeria?
iii. Is there a threshold level of birth rate that will be consistent with optimal population growth in Nigeria?
iv. What is the optimal population growth that can be sustainable for the economic development in Nigeria?

Based on these pertinent questions, this paper seeks to study the demographic dynamics in the Nigerian economy as it affects the development process of the country. The specific objectives are:

i. To empirically ascertain the determining factors of population growth in Nigeria,
ii. To investigate the effect of mortality rate on total fertility rate in Nigeria,
iii. To investigate the optimal birth rate that will not skyrocket population growth in Nigeria,
iv. To determine the optimal population growth level that is sustainable for economic development in Nigeria.

This paper is divided into five broad sections of interest. Following this section 1, which is the introduction, is the literature review portrayed in section 2. Thereafter, we present the methodology of the research in section 3 and then present the empirical findings in section 4. The conclusion of the paper is x-rayed in section 5 which is the last section.

II. LITERATURE REVIEW

A. Demographic Transition Theory

Demographic transition theory envisages that impending population upsurge will follow a four- or five-stage pattern. The demographic transition consists of an initial period with high crude birth and death rates and modest population increase. As cultures progress, death rates fall but birth rates stay high, leading to rapid population expansion. As the evolution is accomplished, birth rates begin to plunge, resulting in a return to reduced population growth (Peterson, 2017). The five-stage pattern is x-rayed as follows:

Death and birth rates are high and generally balanced in stage one, which is the pre-industrial society. The United States in the 1800s is an example of this period (Social Science, 2021). This equilibrium is thought to have existed in all human populations until the late 18th century, when it was lost in Western Europe. In reality, growth rates have been less than 0.05 percent since the Agricultural Revolution more than 10,000 years ago. Because the society is confined by the available food supply at this stage, population growth is normally moderate; consequently, unless new technologies are developed to improve food production, any variations in birth rates are quickly mirrored by death rates.

Death rates decline significantly in stage two, which is associated with a developing country, due to improvements in food supply and sanitation, which extend life spans and reduce sickness. Food supply improvements often include selective breeding, crop rotation, and agricultural practices. Access to technology, basic healthcare, and education are examples of other advancements. Another factor that is frequently mentioned is the growth in female literacy mixed with public health education campaigns.

Birth rates decrease in stage three. Birth rates fall as a result of various fertility factors such as access to contraception, wage increases, urbanization, a decrease in subsistence agriculture, an increase in women's status and education, a decrease in the value of children's work, an increase in parental investment in children's education, and other social changes. The rate of population increase begins to slow. The drop in birth rates in affluent countries began in northern Europe in the late nineteenth century. While advancements in contraception do have a part in birth rate drop, it should be emphasized that contraceptives were not widely available or frequently utilized in the nineteenth century, and hence likely did not play a substantial part in the drop at the time. It is vital to highlight that the drop in birth rates is caused by a shift in values, not only the availability of contraception.

During stage four, both the birth and mortality rates are low. Birth rates may fall substantially below replacement level, as has happened in Germany, Italy, and Japan, resulting in a declining population and a danger to many businesses that rely on population growth. Sweden is now considered to be in this stage. As stage two individuals matures, it places a financial strain on the dwindling working population. Death rates in wealthy nations may remain continuously low or somewhat increase due to increases in lifestyle illnesses

caused by poor activity levels and high obesity, as well as an aging population. By the late twentieth century, birth and mortality rates in wealthy nations had levelled out at lower levels.

Some researchers distinguish a fifth stage of below-replacement fertility levels. Others propose a separate stage five, which includes a rise in fertility. The United Nations Population Fund (2008) divides countries into three categories: high fertility, middle fertility, and low fertility. In addition, low-fertility nations such as China, Australia, and the majority of Europe would experience population decreases of up to 20%.

B. Malthusian Population Theory

Paul Ehrlich (1968) and others revitalized Malthusian viewpoints on the impact of population expansion on social and economic well-being in the later part of the twentieth century, when population growth rates reached extremely high levels, mainly in low-income nations. These writers were concerned that the world's population would outstrip the earth's and its resources' ability to provide food and other necessities for human survival. Many people believed that in order to prevent an existential crisis, both population and economic development should be reduced or eliminated totally. Other writers believed that population growth worries were overstated, saying that population increase would spur technical progress, allowing food supply to keep up with the rising population (Boserup, 1965 cited in Peterson, 2017) or that more numbers of individuals would result in more minds available to solve any resource issues that may occur (Simon, 1981 cited in Peterson, 2017).

Malthus (1978) believed that population may expand beyond the means of sustenance and that certain factors may intervene to restrict population (Effiong, 2019). According to him, ‘‘the difficulty stems from the fact that food availability limits the amount of population that a region can support” (Malthus, 1798). As a result, population expansion is damaging to a country's economy owing to a range of challenges generated by the rise. For example, overpopulation and population growth put enormous strain on resources, resulting in a cascade of difficulties as the country expands (Effiong, 2019).

Malthus (1798) observed that population grows geometrically but food resources expand only arithmetically. According to the Malthusian paradigm, causality is bidirectional. Higher economic growth boosts population through encouraging early marriages, high birth rates, and lowering malnutrition death rates. Increased population, on the other hand, dampens economic growth due to decreasing returns. The dynamic interplay between population and economic growth is at the heart of the Malthusian model, which argues that population has a counterbalancing influence in the long term equilibrium (Thuku, Gachanja, and Almadi, 2013).

C. The Neoclassical Growth Model

Solow's (1956) neoclassical growth model also gives a theoretical explanation for a negative link between population expansion and per capita production growth. This type of model is sometimes referred to as a “exogenous” growth model since the two factors that drive economic growth, savings and population, are exogenous. In these models, fast population expansion results in lower capital per worker, reducing economic growth (Bucci, 2015). Furthermore, it is often considered that rising population mixed with relatively stagnant capital stock expansion results in declining returns.

It is important to note that most theoretical economic growth models do not include population as a determinant in economic production. Instead, the labour force size is the component that is paired with capital to produce GDP. However, in most situations, the population growth rate tends to be used as a proxy for labour force growth, but more complex models also consider labour quality. For example, Mankiw, Romer, and Weil (1990) extend Solow's model to include human capital accumulation, which improves labour-force quality, and find that empirical evidence supports the theoretical result that higher population growth rates lead to lower steady-state economic growth, whereas higher savings rates have the opposite effect (Peterson, 2017).

Empirical research on the impacts of population expansion on economic growth in certain nations has produced inconsistent conclusions. Population increase, according to Sethy and Sahoo (2015) and Tumwebaze and Ijjo (2015), has a favourable influence on per capita economic growth in India and the Eastern and Southern Africa area. On the other hand, it has been argued that “there is a negative association between population increase and per capita GDP growth in China and Australia” (Yao, Kinugasa, and Hamori, 2013; and Banerjee, 2012). According to Huang and Xie (2013), “current population increase has a negative influence on economic growth whereas delayed population increase has a positive effect, indicating that there is no long-term link between these variables” (Huang and Xie, 2013).

Yoo (1994) proposes three models to investigate the influence of increased population growth on U.S. economic growth. He discovers that the enormous rise in the number of children inhibited growth as resources were diverted from more productive activities and directed on education and health care for this huge cohort. Bloom and Canning (2004) also show that when baby boom cohorts enter the labour market and save for retirement, there are beneficial effects on economic development.

According to Becker et al. (1999), population growth in low-income, agricultural societies slows per capita income growth due to diminishing returns to the growing labour force making more intensive use of a fixed resource base, whereas population growth in high-income, urban economies may lead to greater income growth due to increasing returns from greater specialization and growth in human capital

development (Peterson, 2017).Bucci (2015) claims that population expansion has a favourable influence on productivity due to increased specialization, but that larger populations result in more complicated production processes, which negate these gains. According to Kelley and Schmidt (2001) and Mierau and Turnovsky (2014), population growth caused by lowering death rates increases economic growth, whereas population increase resulting from high fertility causes economic growth to slow.As Mierau and Turnovsky (2014) noted, the rationale for these conflicting impacts is that decreases in mortality create incentives for individuals to save more, which encourages growth, whilst increases in fertility have a negative impact on aggregate savings.

Heady and Hodge (2009) discovered that dropping population growth rates in high-income nations delay economic development whereas rising population growth rates in low-income countries delay economic development in a meta-analysis of studies on economic growth and population growth.

On fertility, based on panel data from France from 1876 to 1896, Murphy (2009) discovers that money per capita had a favourable influence on fertility rates during France's demographic transition, even after accounting for schooling, the gender literacy gap, and death rates. Furthermore, Fernández-Villaverde (2001) found that, according to the Beckerian hypothesis, the force associated with a gain in wealth would have resulted in an increase in fertility rates rather than the observed fall in fertility (Galor, 2012).

Using mortality and fertility data from England from 1861 to 1951, Doepke (2005) concludes that, in the absence of changes in other parameters, the drop in child mortality during this period should have resulted in an increase in net fertility rates, contrary to the findings. The study of Fernández-Villaverde (2001) came to a similar result on the insignificance of lowering mortality non explaining the drop in fertility during the demographic transition. Furthermore, Murphy (2009) contends, based on panel data from France from 1876 to 1896, that the death rate had no influence on fertility throughout France's demographic transition, even when education, income, and the gender literacy gap were taken into consideration (Galor, 2012).

III. METHODOLOGY

A. Basic study Design

This study employs an ex-post research design in studying the population dynamics as it affects economic development of Nigeria. The study employs secondary data obtained from secondary source, which were analysed using an econometric software package.

B. Model Specification

The model of the study is specified based on the objectives that are set to be achieved.

Model I: To empirically ascertain the determining factors of population growth in Nigeria, the population growth model is defined as follows:

PGR = f(GPC, CBR, FPI, IMR, FER, SGL)-(1)

Where: PGR = population growth rate

GPC = gross domestic product per capita (a proxy for income)

CBR = crude birth rate

FPI = food production index

IMR = infant mortality rate

FER = fertility rate

SGL = social globalization

Transforming Equation (1) to its estimable form, we have;

$$PGR_t = \gamma_0 + \gamma_1 GPC_t + \gamma_2 CBR_t + \gamma_3 FPI_t + \gamma_4 IMR_t + \gamma_5 FER_t + \gamma_6 SGL_t + \mu_t - (2)$$

Where γ_0 to γ_6 are the parameters to be estimated and μ_t is the error term. It is expected that γ_1, γ_2, γ_3, $\gamma_5 > 0$, and γ_4, γ_6 while < 0.

Model II: To investigate the effect of mortality rate on total fertility rate in Nigeria, we test the prediction that mortality rates have a positive effect on total fertility rates. The model is specified thus:

FER = f(IMR) - - - (3)

Which transforms to

$$FER_t = \beta_0 + \beta_1 IMR_t + \mu_t \text{ -} \quad (4)$$

Where FER is the total fertility rate, IMR is the infant mortality rate, μ_t is the error term, $\beta_0$is the constant and β_1 is the slope coefficient. It is expected that $\beta_1 > 0$.

Model III: To investigate the optimal birth rate that will not skyrocket population growth in Nigeria, the threshold model is specified as follows:

$$PGR_t = \delta_{CBR} + \psi_1 d_t^{CBR}(CBR_t - CBR^*) + \psi_2(1 - d_t^{CBR})(CBR_t - CBR^*) + \varepsilon_t - -(5)$$

Where PGR is the growth rate of population; CBR is the crude birth rate; CBR* is the value used for the iteration process in our search for the optimal threshold point. The effect of crude birth rate is captured by ψ_1 for the period in which the crude birth rate is greater than the threshold (high birth rate regime) while ψ_2 represents the effect of crude birth rate when the crude birth rate is lower than the threshold value (low birth rate regime). The dummy variable for crude birth rate (d_t^{CBR}) is defined as:

$$d_t^{CBR} = \begin{cases} 1 & \text{if } CBR_t > CBR^* \\ 0 & \text{elsewhere.} \end{cases}$$

Model IV: To determine the optimal population growth level that is sustainable for economic development in Nigeria, the threshold model is specified thus:

$$GPC_t = \delta_{PGR} + \varphi_1 d_t^{PGR}(PGR_t - PGR^*) + \varphi_2(1 - d_t^{PGR})(PGR_t - PGR^*) + \varepsilon_t \quad -(6)$$

Where PGR is the growth rate of population; GPC is the growth rate of gross domestic product; PGR* is the value used for the iteration process in our search for the optimal threshold point. The effect of population growth is captured by φ_1 for the period in which the population growth rate is greater than the threshold (high population growth regime) while φ_2 represents the effect of population growth when the population growth rate is lower than the threshold value (low population growth regime). The dummy variable for population growth (d_t^{PGR}) is defined as:

$$d_t^{PGR} = \begin{cases} 1 & \text{if } PGR_t > PGR^* \\ 0 & \text{elsewhere.} \end{cases}$$

C. Sources of Data

Data utilized in this study were obtained from the World Development Indicators (2018), which covers the period 1970 to 2017. Data were collected on key variables of interest which include growth rate of gross domestic product, population growth rate, crude birth rate, infant mortality rate, fertility rate, food production index, social globalization, and fertility rate.

D. Analytical Technique

The estimation technique employed in this study include the ordinary least squares estimation approach and the threshold regression analysis. The ordinary least squares estimation approach was utilized to achieve first (i) and second (ii) objectives, while the threshold regression analysis was utilized to achieve the third (iii) and fourth (iv) objective. The analysis was conducted using the Eviews statistical software package.

IV. EMPIRICAL RESULT

A. Empirical Findings on the determining factors of population growth in Nigeria

The determining factors of population growth is analysed using the *OLS* regression analysis and the result is presented in table 2.

Table 2: OLS Regression Result for Model I

Variable	Coefficient	Standard Error	t-Statistic	Probability
C	-0.8892	1.7662	-0.5035	0.6173
GPC	0.0025	0.0027	0.9195	0.3632
IMR	-0.0117	0.0017	-6.7534	0.0000***
FPI	0.0004	0.0035	0.1197	0.9053
FER	0.1636	0.3016	0.5424	0.5905
BR	0.0899	0.0311	2.8927	0.0061**
SGL	-0.0036	0.0023	-1.5519	0.1284
R-squared	0.6316	F-statistic	11.71415	
Adjusted R-squared	0.5777	Prob(F-statistic)	0.0000***	

Source: Author Computation using Eviews 10.

From the *OLS* regression result, income (GPC), food production index (FPI), and fertility rate (FER) exert positive but insignificant effect on population growth. However, social globalization exerts a negative and insignificant effect on population growth. These are in line with the a priori expectations. From the result, it is observed that infant mortality rate exerts a negative and significant effect on population growth, while crude birth rate exerts a negative and significant effect on population. It follows that a unit percentage increase in infant mortality will lead to a 1.17% decrease in population growth; while a unit percentage increase in crude birth rate will lead to an 8.99% increase in population growth. These are in consonance with the a priori expectation. Thus, increase in infant mortality reduces population growth, while crude birth rate increases the population growth of the country. Thus, to check the population explosion, there is need to manage the birth rate while also reducing the infant mortality which is a driving force in fertility rate. The coefficient of determination (0.6316) shows that 63.16% of the total variations in population growth is explained by the variations in the explanatory variables. Further, the F-statistics (11.714) which is significant at the 1% level implies that the overall model is statistically significant.

B. Empirical Result of the Effect of Mortality Rate on Total Fertility Rate in Nigeria

The result conducted under the OLS framework is presented in Table 3.

Table 3: OLS Regression Result for Model II

Variable	Coefficient	Standard Error	t-Statistic	Probability
C	4.7727	0.1313	36.343	0.0000***
IMR	0.0132	0.0011	11.8165	0.0000***
R-squared	0.7522	F-statistic	139.6299	
Adjusted R-squared	0.7468	Prob(F-statistic)	0.0000***	

Source: Author Computation using Eviews 10.

From the result, it is observed that infant mortality rate has a positive and significant effect on total fertility rate in Nigeria. this aligns with the findings of Doepke (2005). Also, Exogenous child mortality decline should lead to a fertility decline as women have fewer children if they know the chance of their survival is high (Kalemli-Ozcan, 2002 cited in Ranganathan, et al., 2015). Thus, a unit percentage increase in infant mortality will lead to a 4.7727% increase in fertility

rate. The implication here is that if the infant mortality rate is high, there will be the tendency to increase child birth on the premise of having a chance to get a survival child. The coefficient of determination indicates that 75.22% of the total variations in fertility rate is explained by the variations in mortality rate. Thus, to curb high fertility rate, actionable policies should be geared towards reducing infant mortality in Nigeria.

C. Empirical Findings on the optimal birth rate that will not skyrocket population growth in Nigeria

In examining the optimal birth rate that will give rise to optimal population growth in Nigeria, the result of the threshold regression analysis is presented in Table 4.

Table 4: Threshold Regression Result for Model III

Variable	Coefficient	Std. Error	t-Statistic	Probability
CBR < 41.621999 -- 8 observations				
CBR	0.0216	0.0102	2.1206	0.0423**
C	1.7920	0.4065	4.4084	0.0001***
41.621999 <= CBR < 43.684999 -- 16 observations				
CBR	-0.1060	0.0124	-8.5739	0.0000***
C	7.0841	0.5294	13.381	0.0000***
43.684999 <= CBR < 45.965999 -- 9 observations				
CBR	0.0416	0.0143	2.9121	0.0067**
C	0.7214	0.6370	1.1326	0.2664
45.965999 <= CBR -- 5 observations				
CBR	0.3237	0.0360	8.9868	0.0000***
C	-12.400	1.6741	-7.4069	0.0000***
R-squared	0.900	F-statistic	38.60199	
Adjusted R-squared	0.877	Prob(F-statistic)	0.0000***	

Source: Author Computation using Eviews 10.

The result indicates if the crude birth rate exceeds the threshold of 41.62%, population will grow by 2.16%; but at the threshold within 41.62% and 43.68%, there is a decline in the population growth by 10.60%. meanwhile, above the threshold of 43.68% and 45.97%, there is bound to be a population growth of 4.16%; while at the threshold level of 45.97%, the Nigerian population is likely to grow by 32.37%. This indicates that the optimal threshold level of birth rate that will not propel population explosion in the country is 41.62%.

D. Empirical Findings on the optimal population growth level that is sustainable for economic development in Nigeria

The result of the threshold regression analysis to ascertain the optimal population growth level that is sustainable for economic development in Nigeria is presented in Table 5.

TABLE 5: Threshold Regression Result for Model IV

Variable	Coefficient	Std. Error	t-Statistic	Probability
PGR < 2.503846 -- 11 observations				
φ_1	-87.922	22.719	-3.8699	0.0004***
δ_{PGR}	219.632	55.504	3.9571	0.0003***
2.503846 <= PGR -- 37 observations				
φ_2	-4.6733	7.2081	-0.6483	0.5201
δ_{PGR}	16.130	19.127	0.8433	0.4036
R-squared	0.2638	F-statistic	5.2552	
Adjusted R-squared	0.2136	Prob(F-statistic)	0.0034**	

Source: Author Computation using Eviews 10.

From the result of the *threshold regression analysis*, it is observed that the optimal threshold level of population growth is 2.50%. Above this level will cause economic development to decline by 87.922% and below the level, economic development will decline by 4.6799%. The coefficient of determination indicates that 26.38% of variations in economic development is explained by the variation in the population growth. The F-statistic which is statistically significant at the 5% level implies that the overall model is statistically significant. The major finding here is that if the population growth exceeds the 2.50% threshold, there is bound to be a downward pressure on the economic development of the country.

V. CONCLUSION

In this paper, we have analysed the determining factors of population growth in Nigeria, with an insight into the effect of mortality rate on fertility rate. Also, we studied the threshold level of birth rate that is consistent with population growth rate as well as ascertaining the threshold level of population growth that is sustainable for economic development in Nigeria. We utilized the ordinary least squares regression in the first two instances, and then proceed to the threshold regression analysis to the last two instances. From the OLS regression result, we observed that the key determining factors of population growth in Nigeria are infant mortality rate and crude birth rate. These two variables exerted a significant effect on population growth in Nigeria. For instance, infant mortality exerted a negative and significant effect on population growth. Given the partial slope of -0.0117, a unit percentage increase in infant mortality rate will on the average decrease population growth by 1.17% and vice versa. Also, the partial slope coefficient of birth rate (0.0899) is positive and statistically significant at the 1% level. The implication here is that a unit percentage increase in birth rate will on the

average increase the total population by 8.99%. Thus, to check population, there is need to control both the birth rate and the fertility rate.

Given the threshold regression result, we observed that when the birth rate is above 41.61%, the total population will grow by 2.16%. Also, within the threshold of birth rate of 41.62%and 43.68%, the total population will be reduced by 10.60%; while within the birth rate threshold level of between 43.68% and 45.97%, the total population will grow by 4.16%; and at the threshold of above 45.97%, the population will grow by 32.37%. It follows that the optimal threshold level of crude birth rate that will not skyrocket population growth in Nigeria is 41.62%. Above this level, there is likely to be population explosion in the country.

Similarly, the threshold level of population growth that is sustainable for economic development in Nigeria was ascertained to be 2.50%. At the upper population growth (above the threshold level), there is bound to be an -87.922% reduction in economic growth; while at the lower population growth regime (below the threshold level), there is bound to be a -4.6733% decrease economic development (though such effect is not statistically significant). It follows from the analysis that for the country to achieve sustainable economic development, there is need to maintain an optimal population growth that will be consistent with the available resources.

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