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FERTILITY AND POPULATION EXPLOSION IN NIGERIA: DOES INCOME ACTUALLY COUNT?

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ABSTRACT

In Nigeria, this study examined whether income matters in the influence of fertility on population growth from 1961 to 2020. Going specific, we inquired into the influence of fertility and income growth on population growth; the influence of fertility and income growth on birth rate; and the causal linkages between population growth, fertility, birth rate, life expectancy, and income growth. From the 'Granger Causality test, no causality exists between income growth and population growth; but a one-way causality runs from population growth to birth rate. In the 'ordinary least squares' regression utilized in the study, we realized that income does not have any significant influence on population growth and birth rate; but fertility rate and life expectancy at birth wielded a direct and substantial effect on population growth. A 1% increase in fertility and life expectancy increased population growth by 0.4823% and 0.0615% on average and explains about 75.86% of the total variation in population growth. The bounds test shows that no long-run rapport exists between fertility and birth rate. The short-run estimates indicated changes in fertility wielded a positive and significant sway on birth rate, while life expectancy wielded a negative and significant sway on the birth rate. Still, income does not exert any significant influence on the birth rate. The policy implication of these findings is that to curtail population bang, there is a necessity to reduce the birth rate. This is because income does not play any significant role in the demand for children in Nigeria.

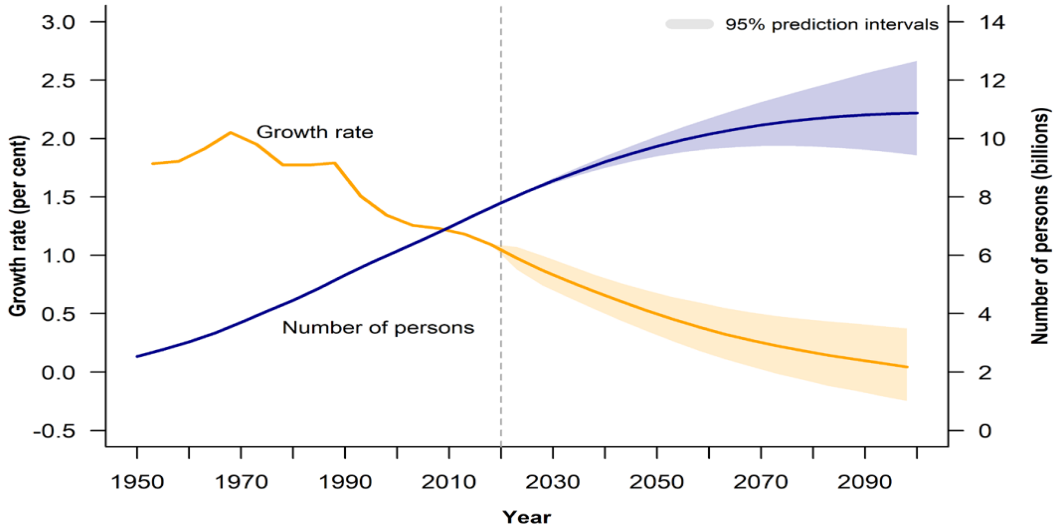
KEYWORDS

Birth Rate, Demand for Children, Life Expectancy, Population Growth.

1. INTRODUCTION

The United Nations (UN) published 'World Population Prospects', its most recent set of two-yearly population forecasts, in June 2013. One of the utmost noticeable adjustments stems from Africa, where fertility projections for several nations have stood significantly swottedaloft (National Transfer Accounts (NTA), 2013). "Although global population growth has decelerated, the NTA's report prompts us that the population of certain developing nations, particularly in Africa, are still increasing quickly," said Wu Hongboan, UN-Secretary-General for Economic and Social Affairs.The Population Council's John Bongaarts voiced worry to the *Los Angeles Times* that "expeditious population growth could exacerbate hunger and poverty in African countries where food, water, and farmland are already scarce" (NTA, 2013). Consistent with the newest UN forecasts, "people in Africa are in more peril than we expected".Soaring fertility has a chief warping sway on population age structure, in addition to hovering the overall amount of individuals who have got to be sustained on aninsufficientmeans. "Large numbers of dependent children dominate high-fertility populations, leaving insufficient resources to raise present consumption or save and invest for the future; even resources for children themselves, such as child health and education, are overwhelmed by the numbers" (NTA, 2013).

With the rising population which puts the forecasted global population at 8.6b in 2030, 9.8b in 2050 and 11.2b in 2100 (United Nations, 2017), the world's population tripled(or even more) since the mid-20th century, graspingover 8 billion persons in 2022, as Figure 1 clearly portrays.



Note: "Prediction intervals (shaded area around a projected trend) were derived from a probabilistic assessment of projection uncertainty. For a given year, the future trend is expected to lie within the predicted range with a probability of 95 per cent".

Figure 1: *World population forecast*

Source: United Nations (2019) cited in Wilmot*et al*. (2022).

As stated by UN estimates, the global population possibly willgraspnearlyeleven billion individuals by 2100. Nonetheless, beginningnearly 1970, "the rate of global expansion has slowed significantly, and the global population is predicted to stabilize by the end of the century" (Wilmot*et al*., 2022).The unparalleled upsurge in worldwide population since 1950 is the product of two movements: "the gradual increase in average human longevity as a result of widespread enhancements in public health, nutrition, personal hygiene, and medicine, and the tenacity of high levels of fertility in many countries" (Wilmot*et al*., 2022).

Nigeria's population is estimated to reach 401.3 million by 2050 (World Bank, 2021), with fertility rate being higher than that of the developed country's counterpart. This high fertility is premised upon by biological and sociocultural factors and theattributes include "high child birth and child mortality rate, early and universal marriage, early childbearing plus childbearing over most of the reproductive life span, poor contraceptive usage, and high societal importance put on childbearing; fear of extinction fostered increased reproduction in the face

of perceived high child mortality, with the expectation that some of the births would survive to carry on the lineage" (Feyisetan and Bankole, 2002). Figure 2 reflects on fertility and diverse population growth indices.

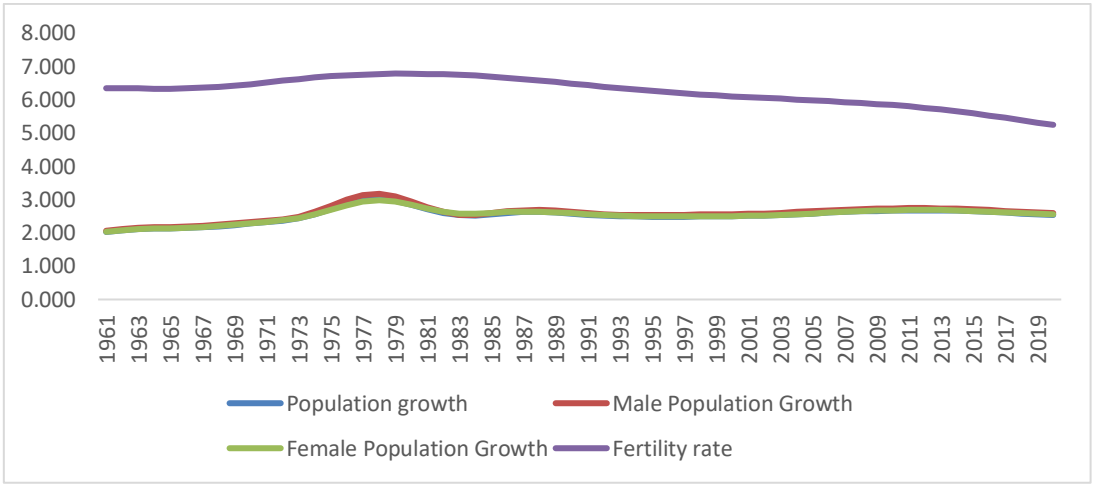


Figure 2: *Fertility and population growth trends in Nigeria*

The behaviour portrayed in Figure 2 is that high fertility rate corresponds with high population growth. With rising fertility in the 1960s and 1970s, population growth is observed to replicate similar trend before reaching a maximum in the 1979 before plunging. This is as result of a concomitant decline in the fertility rates. The fertility rate declined from 6.08% in 2001 to 5.25% in 2020, while population growth increased from 2.51% in 2001 to 2.54% in 2020.

The rising population is attributed also to the declining death rate over the years. Figure 3 portrays this trend.

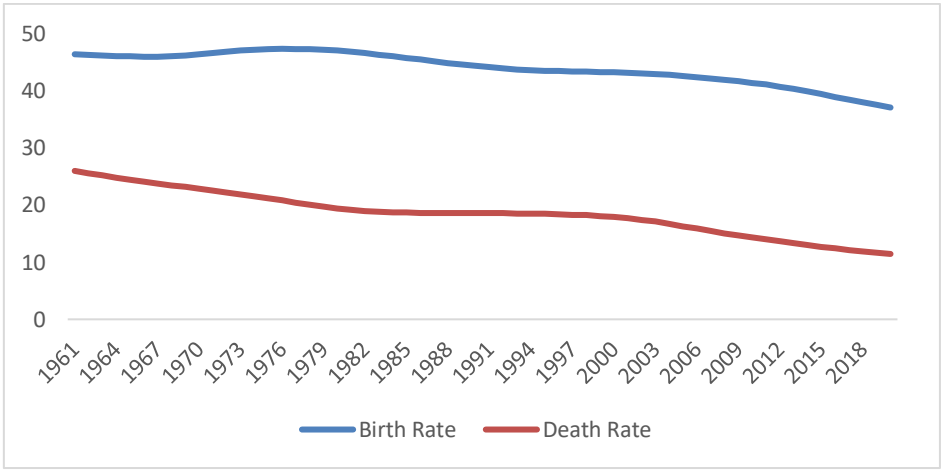


Figure 3: *Birth rate and death rate in Nigeria, 1961 – 2020.*

Death rate declined from 25.941% in 1961 to 19.408% in 1980 before plunging to 17.895% and 14.27% in 2000 and 2010 respectively, and then to 11.422% in 2020. Though birth rate has shown some decline over the years too, the decline is not as high as the decline in death rate. As already stated, these dynamics is owing to "the gradual increase in average human longevity on account of widespread enhancements in public health, nutrition, personal hygiene, and medicine, and the tenacity of high levels of fertility in many countries" (Wilmot*et al*., 2022).

Though the cost of living in Nigeria has been high coupled the high poverty prevalence in Nigeria, the demand for children has never been decreasing given factors like high societal prominence put on childbearing, and fear of annihilation becomes dominant variables in determining birth rates. It could be tagged valid that income could be a very crucial factor in the demand for children given the rising cost of parenting occasioned by the

rising cost of living. Yet, the Nigerian society is still characterised by high birth rate given the social and traditional attachments to child bearing.

Consequently, could it be that income and cost of living do not affect the birth rate which is a crucial driver of population growth? Could it be that the high birth rate is not triggered by income growth, rather by the high fertility rate? The central goal of this is study is to inquire into the role of fertility and income on population explosion in Nigeria. The specific aims are to investigate the impact of fertility rate and income growth on female, male, and total population growth; to examine the role of income growth and fertility on birth rate in Nigeria; and to detect the causal linkages between population growth and fertility.

2. APPRAISAL OF RELATED LITERATURE

The theoretical basis of this study is on "Caldwell's theory of wealth flows", and 'theory of demand for children' based on utility and production function.

2.1 Cadwell's Theory of Wealth Flows

Consistent with Caldwell's theory of wealth flows, "fertility behaviour involves rational decision-making by parents" (Caldwell, 1976a). In relation to the hypothesis, getting more children upsurges family income in soaring fertility atmospheres (Snopkowski and Kaplan, 2014). In certain situations, "children labour at a young age and care for old or unwell parents as adults" (Caldwell, 1976b; Caldwell, 1966). Children's labour and assistance in old age result in children-parents'aids being bigger than parents-children'scontributions across their joint lifespans (Caldwell, 1976a).

Above and beyond the perceptiblesuccour that children bring, big families can be advantageous due to their superior political influence. Families that are enormous also offer risk insurance; example, "if a single family has crop debacle, they can resort to extended family members for support" (Caldwell *et al*., 1985). In such cases, "children are a source of money for parents, therefore they opt to have as many children as they can" (Snopkowski and Kaplan, 2014).

Analliedextrapolation is that "when children failsto earn money to parents and wealth transfers instead flow from parents to children, parents will opt to have reduced fertility" (Snopkowski and Kaplan, 2014). As viewpoints and behavioural customsaccentuate individual undertakings, independence, and welfare over involvement to the extended family, the demographic shift from soaring fertility to truncated fertility epochs starts. Peopleinitiategrowing investments in children, "making them more expensive, as they shift their emotional connection to their spouse and children over extended family, prompting parents to prefer fewer or no children" (Snopkowski and Kaplan, 2014).

The sway of universal education on the family communalarrangement is the ultimateaspect of the initiation of the fertility shift (Caldwell, 1980). While education increases the price of reproduction due to unexploited productivity while schooling, the expense on fees and uniforms, cumtheir desire for consumables, it also modifies society's discernment of childhood. "Couples start to focus on their partner and children above the extended family as countries embrace western idea of nuclear families from mass education and mass media. This shift is what causes fertility to shrink" (Snopkowski and Kaplan, 2014).

Schooling exhibits that humanityperceives children as the future, and children must be consideredbeyond just child labourers. Characteristically, "the earliest cohort of mass schooling is sufficient to cause fertility reduction, as parents learn that they will not gain more from their children than they will have to put in them. Fertility reduction may not begin until those children who attended school become parents in civilizations where the extended family structure can be maintained even with a significant number of youngsters attending school" (Snopkowski and Kaplan, 2014).

Different academics have defined levels of education in assortedmanners, like literacy rates or the fraction of individuals who are educated, but Caldwell contends that mass education (or universal schooling) is the most imperative. "The values surrounding childhood and nuclear families will not change until all (or the vast

majority) of children are educated, and education of women is especially central in driving a swing on the way to nucleation (as women anticipate close sensitive ties with their partner) and greater investment in children; books, newspapers, movies, radio, and television all support western cultural norms of nuclear families and reduced family size as a result of mass education" (Snopkowski and Kaplan, 2014).

Following a reversal of intergenerational income relocations, when parents give more to their descendants than is returned, economic rationality demands no fertility, but social and psychological reasons maintain fertility from plummeting to zero. Fertility diminution"is fundamentally about changing views and ideals regarding family structure, which impacts family economics and resulting in a shifting directional flow of commodities" (Caldwell, 1980). "We can witness cultures with huge urban populations, some proportion of children attending school, and many individuals participating in a market economy, but if income flows continue to migrate from children to adults, high fertility persists" (Snopkowski and Kaplan, 2014).

For a while, outdated value arrangementssubjugatedrejuvenation in somesegments of the universe. As most parts of the world's birth rates commenced to plunge, the idea was reviewed to emphasize the cultural transmission of Western values through mass schooling and cultural diffusion. Thus, in its most current iteration, "the theory looks at fertility transition as a three-part process. The economic expenses of children are affected by the cultural dissemination of individualist Western ideals as it moves around the globe. When such values pervade the cultural setting, children stop to give net wealth flows to parents and cease to boost parental wealth. In turn, the economic impacts of value shift alter fertility aspirations, prompting people to adopt activities that reduce the number of children they have" (Snopkowski and Kaplan, 2014).

2.2 Theory of Demand for Children

2.2.1 The General Household Demand Framework

As Schultz (1997) puts, "parents are anticipated to maximize their lifespan utility, which is determined by six commodities: their number of children, C; their children's average education and health, E and H; the husband and wife's respective average leisure activities, L_h, L_w; and another composite household commodity, G" which is captured as:

$$U = U(C, E, H, L_h, L_w, G) \qquad (2.1)$$

Apiece of these opinions of U may be alleged as being made in the home by constant returns to scale technology with market goods, X, cum the nonmarket time, t, ascribed to husband and wife:

$$i = \beta_i(X_i, t_{hi}, t_{wi}, \mu_i) \qquad (2.2)$$

where i denotes C, E, H, L_h, L_w, and G. A pair-specific feature marked by iimpacts production potential and is partly recognized but not regulated by the couple. "Exogenous genetic or environmental variables, for example, may influence a couple's ability to have children, or fertility" (Rosenzweig and Schultz, 1983).

Becker's (1965) model presupposes that "the distribution of each individual's time among household production undertakings is 'mutually exclusive'; that is, no collaborative production is allowed. This can be eased with minimal additional complexity" (see Rosenzweig and Schultz, 1983). In conjunction with time provided to the market labour force, t_{jm}, the Becker framework's potential uses of time total to an exogenously determined time budget constraint is expressed thus:

$$\emptyset_j = t_{jm} + \sum_i t_{ji} + \sum_j L_j \qquad (2.3)$$

Market income is the lifespan wage rate, W_j, earned by respectiveindividual of the family multiplied by their market labour supply, including income from husband and wife's nonhuman capital endowments, L_{h_h} and V_w. To keep things simple, children are considered to gain property solely as adults.

$$Y = t_{hm}W_h + t_{wm}W_m + V_h + V_w \quad (2.4)$$

Suffice the household production functions portrayed by Equation (2.2) display 'constant returns to scale', and entire family participants work in the market for some time, implying, t_{jm}> 0, full income, F, can be outlined in Equation 2.5 as a "perceived exogenous budget constraint, and the 'shadow prices' of the household merchandises (i.e., π = the opportunity cost of the market goods and household member's time inputs used to produce a unit of the commodity) are then fixed by market-set prices and wages are not subject to the bundle of merchandises consumed by the household. Else, these exogenous shadow pricing will be determined by parent preferences and scale returns" (Pollak and Wachter, 1975). If family participants exit the labour force wholly, no interior solution occurs, and the model becomes more complicated. Full income would become endogenous as it could be determined by fertility if "children worked and their time distribution was an input in the production of E and H. Full income is intended to replace market income as a new exogenous resource restriction that is unaffected by family labour supply decisions in the labour market". Despite these uncertainties for empirical assessments of life-cycle behaviour (Gronau, 1986), the idea of full income is heuristically valuable:

$$F = \emptyset_h W_h + \emptyset_w W_w + V_h + V_w \quad (2.5)$$

Along with Becker's (1965) household production framework, "household behaviour may be seen as cooperatively apportioning time amid market and nonmarket production and merging market goods and nonmarket time to make commodities that are the final source of utility to household members". It also implies that the family may be modelled as a unified optimal consumer, which is now a conventional assumption in neoclassical studies of family labour supply (Killingsworth, 1983).

The conceptual framework's dependency on the presence of a well-behaved nuclear family U is a weakness.In reality, conversely, "the choice issue can be reframed in terms of the restrictions confronting an autonomous individual, as is common in the study of the variables influencing the formation and dissolution of cohabiting partnerships or legally/religiously committed marriages" (Montgomery, 1986; Chiappori, 1992).

Nash-bargaining models of spouse demand behaviour within marriage highlight the different consequence of respective spouse's personal wealth, V_h and V_w, on a spouse's "threat-point." Individualistic methodologies to family conduct focus on "customary arrangements related to family property rights and the provenance of family assets, such as inheritances, gifts, or dowry", with the aim of assigningtitle of these assets to particular family members more correctly."If V_h and V_w impact family demands in the similar manner experimentally, then there is no empirical benefit to maintaining the distinction, and the family utility-maximizing model, which typically pools V_h and V_w, is the most parsimonious depiction of household demand behaviour" (McElroy and Horney, 1978). The inferred neoclassical constraint on family behaviour may be tested if V_h and V_w can be seen independently and reflect equivalent assets, illustration, equally liquid (Schultz, 1990; Thomas, 1990). Maximizing Equation (2.1) subject to Equations (2.2) and (2.3) implies reduced-form demand equations for household produced goods, which may be usually stated as follows:

$$i = Z_i(P, W_h, W_w, V_h, V_w, M, e_i) \quad (2.6)$$

In Equation (2.6), P reflects "the vector of average prices of market goods and public services accessible to the household, M reflects the vector of exogenous household-specific qualities, comprising μ's that shape household's production of i's, and $e_i$are stochastic terms that personify the weights of the couple's inclinations and unnoticed technology plus uncorrelated errors in measurement and specification".

The so derived reduced-form demand functions for market goods (X_i) cum time distributions of household participants (T_{ij}) may be engraved thus:

$$X_i = X_i(P, W_h, W_w, V_h, V_w, M, f_i) \quad (2.7)$$

$$T_{ij} = T_{ij}\left(P, W_h, W_w, V_h, V_w, M, g_{ij}\right) \quad (2.8)$$

Wheref_i and g_{ij} are also uncorrelated stochastic terms.

For the reason that "market pricing, local public programs, life-cycle market wages, and family non-earned income are considered to be exogenous, the reduced-form equations (2.6), (2.7), and (2.8) may typically be approximated reliably using normal single-equation techniques. The reduced-form demand equations incorporate the more fundamental technological factors from the household production functions, Equation (2.2), plus the behavioural demand parameters from the utility function, Equation (2.1)" (see Rosenzweig and Schultz, 1983).

2.2.2 A Simple Production-Demand Model of Fertility

Progenies are thought to be a spring of happiness for their parents, or they possibly will create impending services that parents place a worth on, and their children consume resources that may be used for other purposes (Schultz, 1997). Furthermore, "parents must have some, if imperfect, command over the number of children they have" (see Becker, 1960; Bryant, 1990). If two items are identified that provide utility to parents, children, and a composite bundle of additional goods, G, "certain assumptions about how C and G are created must be made, in addition to the linear homogeneous production technology" suggested by Equation (2.2)(Schultz, 1997).

An empirical overview that applies to most societies is that "the opportunity value of a mother's time in child bearing and rearing exceeds the value of a father's time in child rearing, that is, $t_{wc}W_w > t_{hc}W_h$, and that the value of the mother's time input to children as a share of the total opportunity cost of producing children, known as mother's "time intensity," β_{wc}, exceeds her time intensity in the production of the other good G", i.e., β_{wc}>β_{wg} (Schultz, 1997). Supposing the wage or shadow value of her time rises, the opportunity cost of progeniescompared to other items rises, and if F is unchanging, the demand for children falls. Conversely, "when the woman's pay rises, so does her total income. The (negative) income-compensated price effect of a wage rise for a woman is countered by a (positive) income effect, since children are considered a normal good. So, the perceived uncompensated female pay effect on child demand might be either positive or negative" (Schultz, 1997).

With respect to the male wage, it is less clear "if children are more male-time demanding than the composite product, or whether the income-compensated price effect of the male pay on demand for children is negative, and if so, whether it is substantial enough to balance the positive income effect" (Schultz, 1997). Consistent with the Slutsky equation, "the elasticity of demand for children with respect to the pay of the man or woman in this two-commodity example may be divided into compensated full price (π_c) and full income elasticities (CF)" (Schultz, 1981). Thus,

$$\eta_{CW_j} = \eta_{C\pi_C}(\beta_{jC} - \beta_{jg}) + \eta_{CF}\left(\frac{W_j t_{jm}}{F}\right), j = w, h \qquad (2.9)$$

The CF is weighted by the individual's market earnings, which fluctuate. Thus, "the supposedly positive income impact linked with a man's wage is weighted more strongly than the presumably positive income effect connected with a woman's wage, to the degree that his wage exceeds hers and he works more hours in the market labour force than she"(Schultz, 1997). The compensated price elasticity ($\eta_{C\pi_C}$) is weighted by the variance in temporal intensities in C and G for that spouse.Although this theory does not specify the sign of the male or female pay effect on fertility, "it is evident that the male income will have a larger positive (or less negative) influence on fertility than the female wage"(Schultz, 1981).

Almost all cross-sectional studies of fertility have signposted that "fertility is inversely associated to women's wages, or to the most popular proxy for wages, education" (Schultz, 1976). Thus, the price of a child impact connected with women's pay rates experimentally outperforms the income effect in absolute value. The male salary is frequently connected with increased fertility in traditional agrarian communities, but it has also been found to be associated with reduced fertility in some cases in industrially advanced, high-income civilizations (Schultz, 1997)."The level of land ownership or the value of physical assets is frequently connected with

fertility, still it is debatable if these wealth determinants are truly exogenous, as is commonly claimed within this paradigm" (Rosenzweig and Evenson, 1977; Schultz, 1990).

The core essential conclusion of the household demand framework is that "different sources of family income affect desire for children in different ways. The woman's wage has the greatest negative (or smallest positive) effect on fertility, the man's wage has a less negative or possibly positive effect, and inherited wealth or natural resource income has the greatest positive effect because it lacks any offsetting price effect to deter the demand for children" (Schultz, 1981; Schultz, 1997).

3 RESEARCH METHODOLOGY

3.1 The Model

In modelling the rapport amid population growth and fertility rate, we disaggregate the population growth into female, male, and total population growth as reflected in the following equations:

$$FPG_t = f(FER_t, GPC_t, LEB_t) \quad (3.1)$$

Equation 3.1 opines that female population growth (FPG) at a given time (t) depends on fertility rate (FER), income growth (GPC), and life expectancy at birth (LEB).

$$MPG_t = f(FER_t, GPC_t, LEB_t) \quad (3.2)$$

For Equation 3.2, male population growth (MPG) at time t is defined to depend on fertility rate, income growth, and life expectancy at birth.

$$PGT_t = f(FER_t, GPC_t, LEB_t) \quad (3.3)$$

Equation 3.3 stipulates that total population growth (PGT) at a specific time is defined in terms of fertility rate, income growth, and life expectancy at birth.

In modelling the rapport amid birth rate and fertility rate, the relationship is captured in Equation 3.4.

$$BRT_t = f(FER_t, GPC_t, LEB_t) \quad (3.4)$$

Where BRT is birth rate and the explanatory variables are as earlier defined.

3.2 Econometric Specification of the Model

The econometric specification of the above models is specified thus;

$$FPG_t = \alpha_0 + \alpha_1 FER_t + \alpha_2 GPC_t + \alpha_3 LEB_t + \mu_t \quad (3.5)$$

Consistent with Equation 3.5, α_0 is the constant; α_1 to α_3 are the parameters to be estimated; while μ_t is the error term. The a priori expectation requires that $\alpha_0 < 0, \alpha_1 > 0$, $\alpha_2 > 0$, and $\alpha_3 < 0$.

$$MPG_t = \beta_0 + \beta_1 FER_t + \beta_2 GPC_t + \beta_3 LEB_t + \mu_t \quad (3.6)$$

Following Equation 3.6, the a priori expectation requires that $\beta_0 < 0, \beta_1 > 0$, $\beta_2 > 0$, and $\beta_3 < 0$.

$$PGT_t = \gamma_0 + \gamma_1 FER_t + \gamma_2 GPC_t + \gamma_3 LEB_t + \mu_t \quad (3.7)$$

For Equation 3.7, the a priori expectation entails that $\gamma_0 < 0, \gamma_1 > 0$, $\gamma_2 > 0$, and $\gamma_3 < 0$.

$$BRT_t = \delta_0 + \delta_1 FER_t + \delta_2 GPC_t + \delta_3 LEB_t + \mu_t \quad (3.8)$$

In Equation 3.8, the a priori expectation demands that $\delta_0 < 0, \delta_1 > 0$, $\delta_2 > 0$, and $\delta_3 < 0$.

The expected positive coefficients of income and population growth and birth rate is derived from the demand theory where high income will necessitate high demand for children. Meanwhile, the validity of such claim will be ascertained via the empirical analysis since some households with higher income do have fewer children compared to those with low income.

3.3 The Data and its Sources

In regards to the data, which are time series in nature, we covered the period 1961 to 2020. The selected period, which is 59 years, is long enough to capture the different demographic changes in the country. The key variables upon which data were collected on include total population growth, female population growth, male population growth, birth rate, fertility rate, income growth, and life expectancy at birth. Total population growth, female population growth, and male population growth are expressed in percentages as annual growth; fertility rate is measured in total births per woman; income growth is expressed in percentages as the annual growth in GDP per capita; and life expectancy at birth is expressed in years. The data source is strictly the World Bank (2021) on "World Development Indicators".

3.4 Analytical Procedure

We are utilizing time series data, so it is pertinent to ascertain the "unit root"attributes of the variables at first. The test for "unit root" attributes of the variables are conducted with the aid of the 'Augmented Dickey-Fuller' (ADF) test with the "assumption of a constant and trend". For the test Equation, we portray as follows:

$$\Delta H_t = \alpha_0 + \rho t + \alpha_1 H_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta H_{t-i} + \varepsilon_t \qquad (3.9)$$

It follows from Equation 3.9 that H is the time series variable to be tested for unit root; Δ captures the difference operator; α_0 reflects the constant assumption; ρt portrays the trend assumption; and the summation components captures the augmented component of the test which account for serial correlation. The coefficient to be test is α_1 which states that "there is a unit root in H", expressed as $\alpha_1 = 1$. At 5% level, the rejection of the "null hypothesis" requires that the ADF statistic be more negative than the 5% critical value of the tau (τ) test.

The test is followed by a bounds test where we ascertained the existence of cointegration for the model to be used in analysing the second specific objective; while the 'ordinary least squares' approach is used in analysing the first objective as all the variables in that models were stationary at level. As no cointegration was ascertained to exist in the model analysing the second specific objective, we employed the short-run analysis in the estimation. Thus, the core analytical technique is the OLS approach and the "autoregressive distributed lag" (ARDL) "bounds test for cointegration". In detecting the causal relationship amid the variables, we also put to use the Granger causality test. The test equation is specified thus;

$$X_t = \emptyset + \sum_{j=1}^{n} \beta_j \Delta Y_{t-j} + \sum_{j=1}^{n} \gamma_j \Delta X_{t-j} + \varepsilon_t \qquad (3.10)$$

And

$$Y_t = \emptyset + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{k} \gamma_i \Delta X_{t-i} + \varepsilon_t \qquad (3.11)$$

Equation 3.10 portrays that the current value of X is regulated by the past values of the X and Y. Similarly, the current value of Y is determined by the past values of Y and X, as Equation 3.11 portrays. The test is directed using the F-statistic and the significance of the F-statistics indicates that causality exists otherwise, no causality. The existence of causality can be in two forms: unidirectional (one-way) causality, and bidirectional (two-way) causality. In unidirectional causality, X causes Y or Y causes X. Meanwhile, bidirectional causality entails both variables Causes each other – X causes Y and Y Causes X.

4 EMPIRICAL RESULTS

4.1 Descriptive Analysis

The descriptive analysis focuses on looking at the measures of position and measures of spread; along with graphical analysis.

4.1.1 Measures of Central Tendency and Dispersion

The "measures of central tendency and dispersion" is reflected in Table 1 to capture the descriptive properties of the variables.

Table 1: Descriptive features of the variables

	PGT	MPG	LEB	GPC	FRT	FPG	BRT
Mean	2.531	2.589	45.917	1.141	6.265	2.537	43.925
Median	2.562	2.614	45.923	1.964	6.342	2.581	44.154
Maximum	3.031	3.173	54.687	22.182	6.783	2.982	47.276
Minimum	2.028	2.065	37.431	-17.553	5.317	2.033	37.011
Standard Deviation	0.217	0.235	4.362	6.954	0.399	0.211	2.790
Skewness	-0.326	-0.079	0.077	0.191	-0.577	-0.558	-0.761
Kurtosis	3.343	3.506	2.557	5.087	2.449	3.224	2.706
Jarque-Bera	1.340	0.692	0.540	11.077	4.019	3.187	6.021
Probability	0.511	0.707	0.763	0.004	0.134	0.203	0.049
Observations	59	59	59	59	59	59	

Source: *Researcher Computation (2022)*

Consistent with Table 1, the mean population growth rate for the 59 years is 2.531% while the standard deviation (SD) is 0.217%. This gives a coefficient of variation (CV) of 8.57%. The male population growth (MPG) averaged 2.589% and has a SD of 0.235%; accounting for a 9.08% which is slightly greater than that of the PGT. In a similar case, female population growth (FPG) averaged 2.537% with a SD of 0.211; giving a CV of 8.32%. The CVs of the three population growth indices portray that male population growth has the greatest spread compared to female and total population growth.

Life expectancy at birth (LEB) is noted to have a mean value of 45.92 years with a standard deviation of 4.362 thus giving a CV of 9.50%. The highest LEB for the study period is 54.69 years while the minimum is 37.43 years. Likewise, fertility rate averaged 6.537% and possess a SD of 0.399% thus yielding a CV of 6.10%; and reaching a highest value of 6.783% and a minimum value of 5.317%. The birth rate (BRT) has an average value of 43.925% and the degree of spread is captured by the SD of 2.790% which hitherto yields a CV of 6.35%. Finally, income growth, expressed by the growth rate of GDP per capita (GPC), averaged 1.141% and having a SD of 6.954%. This brings about a CV of 609.47% which indicates a huge dispersion in the variable over the 59 years under reflexion. The minimum income growth was -17.553% while the minimum is 22.182%.

4.1.2 Graphical Explanations

4.1.2.1 Fertility rate and birth rate

It can be duly expected that high fertility rate is likely to amount to high birth rate. This can also hold in the reverse since high birth rate is an outcome of a population with high fertility. Figure 1 represents this relationship.

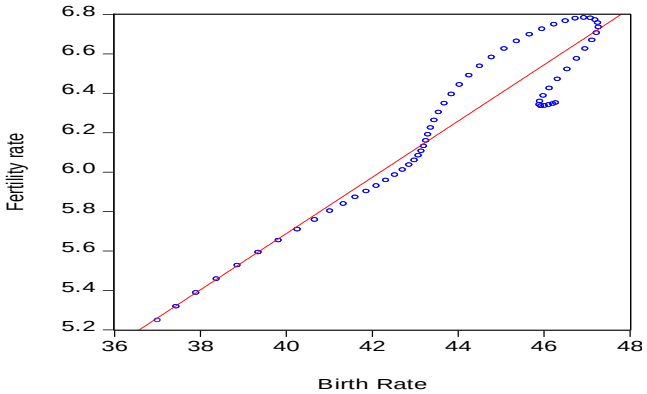


Figure 1: *Graphical relationship between fertility rate and birth rate*

As observed from the scatter diagram in Figure 1, the scatter plots fit closely to the fitted line in the earlier years before some deviations in the future time. Such deviation can be attributed to other factors that could influence birth rate like use of contraceptives, family planning, and cost of child bearing.

4.1.2.2 Life expectancy at birth and birth rate

It is common to see that an inverse relationship will likely exist amid life expectancy at birth and birth rate. This can be derived from the fact that given the probability of survival of a child, a parent will demand for more children if the probability is low, and less if such is high. Figure 2 presents the relationship.

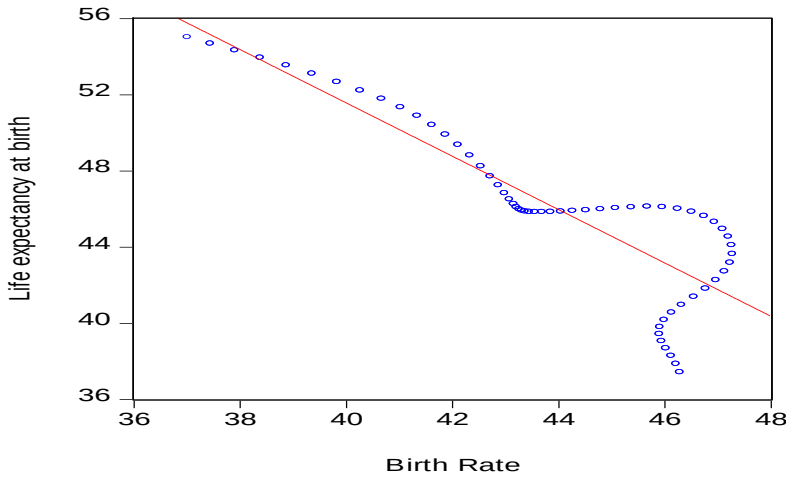


Figure 2: *Scatter plot of birth rate and life expectancy*

It is clear that given the fitted line, Figure 2 expresses an inverse relationship between birth rate and life expectancy at birth. The demand for more children is also premised on their survival at birth, which is also one of the indicators of life expectancy at birth. Given this, a society with low life expectancy will have high birth rate to create a chance for survival of the 'lucky' ones while low birth rate is prevalent in societies with high life expectancy.

4.2 Correlational Analysis

To further portray the form of association amid the variables, Table 2 presents to correlation matrix of the variables.

Table 2: Correlation Result

	PGT	MPG	LEB	GPC	FRT	FPG	BRT
PGT	1						
MPG	0.9973	1					
LEB	0.6079	0.5745	1				
GPC	-0.1942	-0.1803	-0.0968	1			
FRT	0.0145	0.0243	-0.7041	-0.1074	1		
FPG	0.9968	0.9885	0.6394	-0.2090	0.0056	1	
BRT	-0.1823	0.1586	0.8623	0.0255	0.9503	0.2051	1

Source: *Researcher Computation (2022)*

The correlation result indicates that male population growth and female population growth has a fervent and positive correlation with total population growth given their respective correlation coefficient of 0.9973 and 0.9968. Life expectancy at birth also has a strong positive correlation with total population as the correlation

coefficient of 0.6079 portrays. Fertility rate has a positive but very weak correlation with population growth in Nigeria as the correlation coefficient is just 0.0145. This points to the fact that apart from fertility rate, other crucial variables must be there to drive population growth – means of subsistence. In contrast, the correlation concerning income growth and population growth is negative and weak as the correlation coefficient is only 0.1942. The same case is evidenced between population growth and birth rate as the correlation coefficient is -0.1823. Though one may expect the correlation between PGT and BRT to be positive, the negative correlation can be linked to the rising emigration within the country. There is a high correlation amid male population growth and female population growth given the correlation coefficient of 0.9885. Consequently, we will treat the two variables in a different model rather than including them together as a variable that influences population growth. Same scenario is observed between life expectancy and birth rate (0.8623) and between fertility rate and birth rate (0.9503). These high correlations are not a problem since the variables are not being represented as explanatory variables in the same model.

4.3 Granger Causality Test

To decipher the nature of causality that exist among the variables, the Granger causality test is conducted and Table 3 portrays the result.

Table 3: Result of the Granger causality test

Null Hypothesis:	Observations	F-Statistic	Probability
MPG "does not Granger Cause" PGT		46.7199	0.0000***
PGT "does not Granger Cause" MPG	58	46.7426	0.0000***
LEB "does not Granger Cause" PGT		2.20979	0.1197
PGT "does not Granger Cause" LEB	58	8.00604	0.0009***
GPC "does not Granger Cause" PGT		0.84135	0.4369
PGT "does not Granger Cause" GPC	57	2.77665	0.0715
FRT "does not Granger Cause" PGT		0.08940	0.9146
PGT "does not Granger Cause" FRT	58	33.7045	0.0000***
FPG "does not Granger Cause" PGT		42.8841	0.0000***
PGT "does not Granger Cause" FPG	58	40.5838	0.0000***
LEB "does not Granger Cause" MPG		2.37173	0.1032
MPG "does not Granger Cause" LEB	58	6.99828	0.0020**
GPC "does not Granger Cause" MPG		0.95385	0.3919
MPG "does not Granger Cause" GPC	58	2.88376	0.0649
FRT "does not Granger Cause" MPG		0.04560	0.9555
MPG "does not Granger Cause" FRT	58	29.5018	0.0000***
FPG "does not Granger Cause" MPG		44.9255	0.0000***
MPG "does not Granger Cause" FPG	58	42.4947	0.0000***
GPC "does not Granger Cause" LEB		8.45605	0.0007***
LEB "does not Granger Cause" GPC	58	0.10307	0.9022
FPG "does not Granger Cause" BRT		25.4081	0.0000***
BRT "does not Granger Cause" FPG	58	0.77308	0.4667
GPC "does not Granger Cause" BRT		0.38423	0.6829
BRT "does not Granger Cause"GPC	57	2.73378	0.0743
LEB "does not Granger Cause" BRT		45.4382	0.0000***
BRT "does not Granger Cause"LEB	58	40.6261	0.0000***
MPG "does not Granger Cause" BRT		22.6590	0.0000***

BRT "does not Granger Cause"MPG	58	0.28643	0.7521
PGT "does not Granger Cause" BRT		23.8244	0.0000***
BRT "does not Granger Cause"PGT	58	0.44693	0.6420
FRT "does not Granger Cause" BRT		6.81543	0.0023**
BRT "does not Granger Cause" FRT	58	26.8028	0.0000***

*Note: ** and *** respectively portrays that the variable is significant at 5% and 1%*

Source: *Researcher Computation (2022)*

Table 3 indicates that a two-way causation runs amid male population growth and total population growth, implying that as population grows; the proportion of male population also increases, and this in turn increase the rate of procreation. A two-way causation also runs amid female population growth and total population growth. A two-way causation is observed to run amid male population growth and male population growth. The implication is that both aids in the increase in the other. It is further accounted that a one-way causation runs from income growth to life expectancy at birth, implying that income is of great importance for a healthy living. A one-way causation further runs from female population growth to birth rate, signalling that female population dictates the birth rate of the country. Similarly, a one-way causation runs from male population growth to birth rate. A two-way causation also runs amid life expectancy at birth and birth rate. Hence, both variables cause each other. A one-way causation also run from population growth and birth rate. A two-way causation subsides amid fertility rate and birth rate, implying that fertility causes birth rate and birth rate also causes fertility rate. Whether the existence of causality wields any substantial sway on population growth will be detected in subsequent analysis.

4.4 Unit Root Test

In the quest to detect the stationarity attributes of the variables, the "Augmented Dickey-Fuller" (ADF) test for stationarity is put to use and Table 4 reflects the result.

Table 4: Result of stationarity test

Variables	I(0) ADF Statistic	5% Critical Value	Probability	Order of Integration
PGT	-9.2267	[-3.5043]	0.0000***	I(0)
MPG	-9.0365	[-3.5043]	0.0000***	I(0)
LEB	-4.5907	[-3.4921]	0.0027**	I(0)
GPC	-4.6184	[-3.4892]	0.0024**	I(0)
FRT	-3.5895	[-3.4937]	0.0421**	I(0)
FPG	-9.2975	[-3.5043]	0.0000***	I(0)
	I(0) ADF Statistic	I(1) ADF Statistics	Probability	Order of Integration
BRT	-0.0500 [-3.4953]	-3.6995 [-3.4953]	0.0309**	I(1)

*Note: ** and *** respectively portrays that the variable is significant at 5% and 1%*

Source: *Researcher Computation (2022)*

Consistent with the result portrayed in Table 4, it is clear that population growth (male female, and total), life expectancy at birth, income growth, and fertility rate are stationary at level being that the I(0) critical value is more negative than the 5% critical value. Therefore, the null hypothesis that "there is unit root" is overruled.It follows that for analysing our first objective of ascertaining the sway of income growth and fertility on population growth, an OLS estimation technique will be sufficient. In contrast, birth rate only became stationary after first difference, making it to be stationary at first difference. Thus, analysing the second objective will require the use of the ADRL to ascertain both the short-run and long-run rapport amid income growth and fertility on birth rate in Nigeria.

4.5 Bounds Test for Cointegration for Objective II

For the fact that birth rate was stationary at first difference, we cannot put to use the OLS in analysing the second objective since it may yield "spurious regression" result. It is pertinent to examine the existence of cointegration to detect a possibility of a short-run liaison. The ARDL bounds test for cointegration id put to use in this regards and Table 5 portrays the result.

Table 5: Result of the Test for Levels Relationship

Null Hypothesis:		*No levels relationship*		
Test Statistic	Value	Significance Level	I(0)	I(1)
F-statistic	1.0527	10%	2.37	3.2
k	3	5%	2.79	3.67
		1%	3.65	4.66

Source: *Researcher Computation (2022)*

Since it is a requirement that for cointegration to exists, the F-statistic must be greater than the 5% critical value, we can say that "there is no levels relationship" thus, "cointegration does not exists". This conclusion is derived from the fact that the F-statistic (1.0527) is less than the 5% critical values at the lower (2.79) and upper bound (3.67). Therefore, we cannot accept the null hypothesis of "no levels relationship". Since cointegration does not exists, we will only be concerned in estimating only the short-run coefficients of the independent variables.

4.6 OLS Regression Result for Objective 1

In detecting the sway of income and fertility on population growth in Nigeria, we disaggregate it into female, male, and total population growth. Table 6 portrays the result.

Table 6: Result of the OLS Regression

Variables	Model I FPG	Model II MPG	Model III PGT
FRT	0.4810 (0.0000)***	0.5073 (0.0000)***	0.4823 (0.0000)***
GPC	0.0004 (0.8332)	0.0009 (0.7321)	0.0006 (0.7694)
LEB	0.0621 (0.0000)***	0.0638 (0.0000)***	0.0615 (0.0000)***
C	-3.3328 (0.0000)***	-3.5202 (0.0000)***	-3.3142 (0.0000)***
R-squared	0.8209	0.6955	0.7586
Adjusted R-squared	0.8111	0.6789	0.7455
F-Statistic (Probability)	84.0396 (0.0000)***	41.8682 (0.0000)***	57.6217 (0.0000)***

*Note: *** portrays that the variable is significant at 1%*

***Source**: Researcher Computation (2022)*

An overview of Table 6 reflects similar variables that significantly influence female, male, and total population. Fertility rate is one of the key variables that wields a positive and weighty sway on population growth. A high fertility rate will lead to a rising population, and vice versa. As the coefficients submits, a unit percent increase in fertility rate will increase male, female, and total population growth by 0.4810%, 0.5073%, and 0.4823% respectively. Similarly, life expectancy at birth also holds a positive and noteworthy waves on population growth. A unit percent increase in life expectancy at birth increases female, male and total population growth by 0.0621%, 000638%, and 0.0615% respectively. GDP per capita growth (reflecting income growth) is noted to wield a positive but insignificant sway on population growth. Though the positive influence signals that high income could increase the demand for children which will culminates to high birth rate and resultant increasing

population, the insignificance portrays the fact that income does not actually count in the rising population in Nigeria. It is often observed that even poor household has many number of children compared to households with greater endowments. As earlier stated, children are viewed as a future investment and given the uncertainties of them having a brighter future, a poor household can produce more children to try their odds. That is, out of the very many children, some could have a chance to become prominent individuals in the society. Apart from that, some traditional Nigerian households views greater number of children as a strength to the family in terms of providing family labour at the subsistence level.

Given the importance of the aforementioned variables, female, male, and total population growth will be -3.33%, -3.52%, and -3.31% respectively. This portrays that holding fertility rate, life expectancy at birth, and income constant, the Nigerian population will decline drastically by approximately 3% on the average. Also, the aforementioned variables explain 82.09%, 69.55%, and 75.86% of the total variations in female, male, and total population growth, given their respective r-squared. The overall models are statistically significant at 1% level given that the F-statistics are statistically significant.

4.7 Short-run Estimates for Objective II

Since there was no cointegration in the model, only the short-run estimates is estimated to analyse the second objective. Table 7 captures this short-run estimates.

Table 7: Result of the short-run regression analysis

Dependent Variable:			Birth Rate	
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Δ(FRT)	5.3754	0.3231	16.6350	0.0000***
Δ(GPC)	-0.0001	0.0014	-0.0890	0.9294
Δ(LEB)	-0.2151	0.0545	-3.9499	0.0002***
C	0.0074	0.0215	0.3430	0.7329
R-squared	0.8394	F-statistic	94.0639	
Adjusted R-squared	0.8305	Prob(F-statistic)	0.0000***	

*Note: *** portrays that the variable is significant at 1%*

***Source**: Researcher Computation (2022)*

The result in Table 7 portrays the short-run sway of selected variables on birth rate in Nigeria. It is noted that fertility rate is a driving force in birth rate. High fertility is associated with high birth rate in Nigeria since changes in fertility rate posed a positive and substantial sway on birth rate at the 1% level of significance. It is derived from the coefficient that if fertility rate increase by 1%, birth rate will increase by 5.3754% on the average, which could lead to population explosion. Thus, increased fertility will increase population growth via high birth rate. On the contrast, changes in income growth wielded a negative but insignificant short-run influence on birth rate. The implication is that income does not matter in Nigeria when considering birth rate. meanwhile, life expectancy at birth wielded a negative and momentous short-run influence on birth rate at the 1% level. A 1% increase in life expectancy at birth reduces birth rate by 0.2151% on the average. The implication is that the probability of children surviving till adulthood also determine the number of children that a household could have which is a clear indicator of birth rate. If the odds are high, few births will be recorded but if it is low, many births will be recorded to create a cushion for those that may not survive.

Holding these variables constant, birth rate will be barely 0.0074% on the average which is very low. This points out the importance of these variables in intensifying birth rates in Nigeria. The variables jointly explain 83.94% of the total variations in birth rate as reflected by the R-squared. Such explanatory power remains high at 83.05% after some degree of freedom has been accounted for. The F-statistic of 94.0639 which is significant at 1% given the probability of 0.0000 is a clear indication that the overall model is statistically significant and potent for policy making.

4.8 Discussion of Key Findings

The crucial findings of the study are abridged thereof:

i. Income has no substantialsway on population growth and birth rate in Nigeria. It implies that even poor households can still bear more children provided that the fertility rate is high. Given that income does not affect birth rate, the demand for children is income inelastic. Consequently, birth rate will still be high even at a high cost of living leading to a rising population trend in the country.
ii. Fertility rate has a positive and noteworthyinspiration on birth rate and population growth. High fertility in woman is a clear indication of high birth rate. consequently, a higher birth rate holding death rate and net migration constant will culminate to a rising population trend in an economy.

Life expectancy at birth wielded a negative and substantial influence on birth rate, but put forth a negative and noteworthy sway on population growth. It follows that high life expectancy will lead to low birth rate while low life expectancy will call for high birth rate. Such high birth rate arising from low life expectancy is to account for the odds of survival of infants before adulthood. This is a clear picture in the developed and developing economies, where developed countries with high life expectancy at birth has low birth rates and developing countries with lower life expectancy has high birth rates.

5 CONCLUSION

The teeming population in Nigeria has been underutilized given the rising unemployment which has created diverse socio-economic and political crisis in the country. Meanwhile, an estimate of 401.3 million has been put forth to be the population of Nigeria by 2050 and ranked as the third most populous country in the world. This raises some concerns on the future of Nigeria – will it make good of the population or will be bewildered with the impending population explosion? Studies has shown that population growth has positive and significant sway on GDP growth of a nation (see Ali *et al*., 2013; Shah *et al*., 2015; Mohsen and Chua, 2015; Garza-Rodrigue*et al*., 2016; Ogunleye*et al*., 2018); while some has recorded a negative effect (see Klasen and Lawson, 2007; Heady and Hodge, 2009; Afzal, 2009; Okwori*et al*., 2015). Given these recorded negative influence, it could be stated that rising population without adequate policies and programme to tackle its attendant socio-economic and political vices could spell doom to a nation. Malthus (1798) has also predicted diverse checks that are inevitable is the population is allowed to grow uncontrollable given the limited means of subsistence (Effiong, 2019). As argued by Okijie and Effiong (2021), it is an imperative for an optimal population growth threshold to be implemented to avoid the impending doom that may unfold, and to foster sustainable economic development.

Since income growth does not have any substantial influence on population growth and birth rate, this paper concludes that income does not matter in the rising population growth arising from higher birth rate. The quest for natural procreation and the thought that children are investment could be the other key issues that could be driving high birth rate accompanied by the rising population in the country. Population control is therefore sacrosanct to save the nation from peril. This can be achieved via education birth control which are critical for the reduction in birth rate which is seen to be a key driver of population explosion.Lowering birth rates through expanded access to high-quality reproductive health care remains the most practicable policy choice for developing nations with limited resources to deliver key public goods and stimulate job creation. The best technique for lowering fertility is to lower infant mortality. It may be accomplished by increasing the number of health professionals through expanding access to health services and supporting midwifery and nursing vocational schools. These strategies can not only lower baby and maternal death rates, but also increase human quality.

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