CHAPTER FOURTEEN

POPULATION DYNAMICS, HUMAN CAPITAL DEVELOPMENT AND ECONOMIC GROWTH IN NIGERIA

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Abstract

This study investigated the transmission effect of population growth on economic growth through human capital development in Nigeria, covering the period from 1983--2022. The study relied on secondary data sourced from the Central Bank of Nigeria (CBN) statistical bulletin and the World Bank development indicators. The augmented Dickey–Fuller unit root test was used to examine the stationary properties of the data. Additionally, structural vector autoregressive models were employed for analysis. The findings indicated an insignificant negative instantaneous effect of economic growth on population growth and human capital development in Nigeria. Regarding the transmission effect of population growth and human capital development on economic growth, the study concluded that population growth had a positive effect on Nigeria's economic growth through human capital. However, this positive effect was only realized in the long run. The study, therefore, recommended sustained investment in education, skills, and healthcare. It also suggested that governments at all levels should develop and implement comprehensive, long-term strategies to improve the quality of education, vocational training, and healthcare services, fostering a skilled and healthy workforce over time.

1. Introduction

Economic growth is a central goal for nations around the world and achieving sustained and robust economic growth is a primary objective for governments and policymakers. Economic growth can improve the standard of living, reduce poverty, and create opportunities for a better quality of life for citizens (Kuznets, 1934). However, the path to economic growth is influenced by a multitude of factors, and among these factors, population growth and human capital play critical roles as potential drivers of this growth.

The dynamics of population growth, economic development, and human capital formation are topics of profound significance at the global level. In theory, several arguments exist on the relationship between population growth and human capital and how these variables drive economic growth. On one hand, it has been argued that a growing population can contribute to economic growth by increasing the size of the labor force. This can potentially lead to higher production levels and increased economic output. Solow (1956) introduced the concept of the "demographic dividend," suggesting that when the proportion of the working-age population is high relative to that of dependents (children and elderly), there is potential for greater economic growth, as exemplified in the Asian tiger economies (Taiwan, Singapore *et al*.). Moreover, a larger population can provide a greater pool of human resources, which, when properly educated and trained, can contribute significantly to economic development. Becker (1964) emphasized that investments in education, healthcare, and skill development can lead to a more productive workforce, positively affecting economic growth. On the other hand, the theoretical literature shows that a rapidly growing population can strain available resources, leading to overpopulation. This, according to Malthus (1798), can result in increased competition for resources such as land, water, and food, potentially hampering economic growth. In support of this, a high population growth rate with a significant proportion of dependents, such as children and elderly individuals, can lead to a high dependency burden. This means that a larger portion of the population does not actively contribute to the workforce, potentially reducing economic growth (Bloom *et al*., 2001).

In the 20th century, the global population experienced unprecedented expansion, and by 2020, the world had reached nearly 7.8 billion people (World Bank, 2021). This demographic surge has sparked extensive discourse on the relationship between population dynamics and economic growth. The effects of population growth on economic growth have been scrutinized through various lenses. Economists have posited theories suggesting that a growing population can act as a catalyst for economic advancement by expanding the labor force and consumer base (Easterlin, 1967; Bloom & Williamson, 1998). Conversely, concerns have been voiced regarding the potential constraints and resource pressures that rapid population growth may impose (Malthus, 1798).

The role of human capital development emerges as a pivotal determinant in shaping the trajectory of economic growth. Human capital encompasses education, healthcare, and skills, representing the collective knowledge and abilities of a population (Becker, 1964). Economists have long recognized the importance of human capital development in sustaining economic growth, dating back to the 18th century. In his concept of fixed capital, which he deemed critical for economic progress, Adam Smith (1776) emphasized the importance of education, specifically the role of acquired and useful abilities of members of society. By highlighting the importance of education as a national investment, Alfred Marshall (1890) further buttressed this idea and regarded it as the most valuable of all capital invested in human beings. Human capital became popular in the mid-twentieth century (Becker, 1964; Grossman, 1972; Mincer, 1958; Schultz 1961; Uzawa, 1965; Mankiw *et al*, 1992). These studies demonstrated that human capital, such as physical capital, could be improved through education, health, and training, resulting in increased output and economic growth. In this sense, education affects the effectiveness of labor and the level of technical progress—which, in turn, affect the economic growth of a country. On the other hand, improved health status is also vital for sustained economic growth since healthy workers are usually productive.

However, it is crucial to recognize that the impacts of these population dynamics and human capital development are not uniform

across the globe. Developing economies, particularly those in Africa, face distinct challenges and opportunities in navigating the complex interplay between population growth and economic development. Africa, with its youthful demographic profile, is poised to experience significant population growth in the coming decades, raising questions about its potential to harness this "demographic dividend" (Bloom *et al*., 2014) while addressing pressing challenges related to education, healthcare, and employment.

Nigeria, as one of Africa's most populous nations, stands at the epicenter of these demographic and developmental shifts. With a population that surpassed 200 million in 2020 (World Bank, 2021), Nigeria exemplifies both the promise and complexities associated with population growth. Given the potential benefits of a growing population while paying attention to the development of human capital, the Nigerian government has made frantic efforts in the drafting and implementation of policies, programmes, schemes and the establishment of relevant institutions for the development of human capital. Some of these include, inter alia, the Eric Ashby Commission (1959), the Universal Primary Education (1976), the Universal Basic Education (UBE), the Industrial Training Fund (ITF), the Education Trust Fund (ETF), the Petroleum Trust Development Fund (PTDF), and the National Economic Empowerment Development Strategy (NEEDS). All these programmes and policies highlight the relevance of human capital in achieving economic growth in Nigeria. One of the most important developments in recent times was the Economic Recovery and Growth Plan (ERGP) in 2017. The plan was intended to invest in Nigerian people by increasing social inclusion, creating jobs and improving the human capital base of the economy.

The paradox surrounding this is that despite the enormous investment in education, health care and skill development, there is no strong evidence of growth-promoting externalities of human capital in Nigeria. Rather, education expansion (for example) has inculcated negative social changes such as cultism, sexual harassment, sorting, rent seeking, and industrial disputes, among other social vices in the Nigerian school system and society. Despite the number of studies that have been carried out, there remains controversy on how population,

human capital development and economic growth are related, with studies yielding conflicting results (Mohsen & Chua, 2015; Okwori *et al*., 2015; Aidi *et al*., 2016; Kazmi *et al*., 2017; Alatas & Cakir, 2016; Sunmoni, 2015; Zivengwa *et al*. Jihene, 2013). Furthermore, most of these studies could examine only the direct impacts of population growth and human capital development on economic growth. This study therefore seeks to empirically investigate the effects of population growth on economic growth through human capital development and the combined effects of population growth and human capital development on economic growth in Nigeria.

2. Literature Review

Theoretical Framework

The relationships among population growth, human capital, and economic growth are deeply ingrained in economic theory, serving as a crucial framework for understanding the dynamics of demographic changes, investments in human capabilities, and their impact on the economic trajectory of a nation. The study considered two (2) theories to explore this relationship, as described below:

a) Demographic Dividend Theory: The demographic dividend theory, initially formulated by economists such as David Bloom and David Canning (2008), is rooted in the concept that the population age structure plays a significant role in economic development. This theory is valid under the assumption that a significant proportion of the population falls within the working-age group (15--64 years). Additionally, the country makes adequate investments in education, healthcare, and other factors that enhance human capital development; economic policies are assumed to be in place to facilitate job creation, entrepreneurship, and labor market participation among the working-age population. The theory also assumes that a substantial part of the income earned by the working-age population is saved and invested in productive activities rather than being consumed or wasted. The main idea of this theory revolves around the potential economic benefits that can be harnessed during a specific phase of demographic transition when a country experiences a unique age

distribution. This theory posits that during a demographic transition, when the proportion of the working-age population (15--64 years old) is larger than the dependent population (children and the elderly), a demographic dividend can be realized. This dividend occurs when the working-age population is more productive and saves a significant portion of their income. The Asian tiger economy has been cited as a good example of this theory. This theory has been criticized on many grounds. The demographic dividend is a temporary phenomenon that occurs during the demographic transition. As populations age, the dividend diminishes and eventually becomes a demographic burden. Moreover, estimating the exact magnitude of the demographic dividend can be challenging, and projections are based on various assumptions. In some cases, policymakers may overestimate the dividend's size, leading to unrealistic expectations. Furthermore, the theory fails to fully account for external factors such as global economic conditions, trade policies, and technological changes, which can influence a country's economic growth independently of its demographic structure. Despite these weaknesses, the theory serves as a tool to influence economic growth by guiding strategic investments in human capital, reducing poverty, and enhancing a country's competitive advantage.

b) The Solow–Swan Model: The Solow–Swan model, also known as the neoclassical growth model, is a fundamental framework in economics that explains the long-term economic growth of countries. Robert Solow and Trevor Swan initially developed this theory in 1956. The basic assumptions are as follows: a single homogeneous good, a well-behaved neoclassical production function, exogenous labor-augmenting technological advancement, full employment, and exogenous labor force expansion. Solow enhanced the Harrod–Domar model by including labor as a factor of production and capital–output ratios that are not set in the Harrod–Domar model. These refinements distinguish increasing capital intensity from technological advancement. The main idea of the Solow–Swan model is to

explain the long-run economic growth of an economy in terms of its capital accumulation and technological progress. The model suggests that economies converge to a stable state, known as the "steady state," where capital per worker and output per worker reach constant levels. Economic growth occurs through increases in capital accumulation, but this growth is subject to diminishing returns, meaning that as an economy accumulates more capital, the additional output produced by each unit of capital diminishes. The Solow–Swan model follows an aggregate production function, with constant returns to scale in labor and reproducible capital, as represented in the functional form below:

$$Y = F(K, L) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.1$$

where Y is output (or income), K is the stock of capital, and L is the labor force.

The function explains the output, Y, under a given state of knowledge with a given range of available techniques and a given array of different capital, intermediate goods and consumption goods. With constant returns to scale, labor productivity measured by output per worker $y \equiv Y/L$ will depend on the capital stock per worker (i.e., capital intensity, $k \equiv K/L$). Under the assumption of constant returns to scale, the relationship that each unit of labor has with capital in production does not change with the quantity of capital or labor in the economy. A crucial property of the aggregate production function is that there are diminishing returns on the accumulation of capital. In other words, each additional unit of capital used by a worker produces a decreasing amount of output (2). A form called the Cobb–Douglas function usually expresses the relationship:

$$Y = K^{\alpha}L^{1-\alpha}, 0 < \alpha < 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.2$$

α is the elasticity of substitution (factor share in income) of physical capital, which implies that labor productivity can increase given that capital deepens. This model is modified by introducing a productivity (or technology) parameter, A, in the aggregate function, reflecting the current state of technological know-how. Hence,

$$Y = f(A, K, L) \text{ ----------2.3}$$

Mankiw, Romer, and Weil (1992) extended the Solow–Swan model by incorporating human capital, recognizing that knowledge and skills are essential contributors to economic growth. They introduced the concept of human capital (H) and modified the production function to include both physical capital and human capital. The basic assumption in this approach is that an increase in workers' quality—through improved education and health—improves output. The general form of the augmented Solow model is as follows:

$$Y = AK^{\alpha}H^{\beta}L^{1-\alpha-\beta} \text{ ……2.4}$$

where α = elasticity of physical capital with respect to output and β = elasticity of human capital with respect to output.

In this extended model, human capital (H) is accumulated through investments in education and training, similar to the way physical capital (K) is accumulated through savings and investment. The inclusion of human capital allows for a more comprehensive explanation of economic growth, accounting for the role of knowledge and skills in enhancing productivity and technological progress. However, the theory has been criticized on different grounds. One of the criticisms is that it is difficult to test; the quality of education is not considered, and those who make investment decisions cannot calculate its possible rate of return (Habison, 1962). However, the theory remains relevant for this study, as it is the most influential economic theory of Western education.

Empirical studies

The relationship between population growth and economic growth is a dynamic and extensively studied topic in economics. Empirical studies have produced various findings, and the effects can be both positive and negative depending on several factors and the specific context. On the one hand, an increase in population can lead to a larger labor force, which, when properly utilized, can contribute positively to economic growth. When a country experiences an increase in population, it often results in a larger working-age population. This

demographic shift can expand the labor force, which comprises individuals who are of working age and actively participate in the workforce (Olusogo, *et al*, 2018; Tartiyus, 2015, Mahmud, 2015, Orumie & Cynthia, 2016). On the other hand, the empirical literature highlights the potential negative consequences of rapid population growth. Malthusian theory (Malthus, 1773) stands at the center of this viewpoint. This stand of literature centers on the idea that unchecked population growth can strain resources and infrastructure. Dasgupta (1995) underscores that overpopulation can lead to overcrowding, resource depletion, and environmental degradation, potentially hindering economic growth. To support this, empirical evidence is available in the works of Okwori *et al*. (2015), who empirically examined Malthusian population theory in Nigeria from 1982--2012. The study applied a vector error correction model, and the results revealed that population growth has no significant effect on economic development in Nigeria. In other words, the Malthusian population theory is relevant when it is applied to the Nigerian economy. Ewugi and Yakubu (2012) examined Malthusian population theory and the Nigerian economy. Using the political economy approach, the study revealed that more than two hundred years after his work, indices show that the theory's predictions, in some ways, apply to Nigeria. Other studies (Solow, 1956; Coale, Hoover, 1958; Ehrlich, 1968; Zhang, 2007; Herzer, *et al*., 2012, just to mention a few) have also documented a negative influence of population growth on economic growth. These studies, however, only looked at population growth without factoring human capital in the growth equation.

One of the fundamental mechanisms through which human capital accumulation contributes to economic growth is by enhancing labor productivity. Several studies have demonstrated that a well-educated and skilled workforce is more efficient and productive. For instance, Mankiw, Romer, and Weil (1992) argue that human capital is a significant determinant of labor productivity and, consequently, economic growth. The trade-off between the quantity and quality of education in the face of a growing population remains a complex issue that involves difficult resource allocation decisions. Emphasizing quantity often means expanding access to education by building more

schools, hiring more teachers, and providing scholarships or incentives to increase student enrollment (Muralidharan & Sundararaman, 2011; Duflo, 2015; Kremer & Miguel, 2007). The goal is to ensure that a larger portion of the population has access to educational institutions. Prioritizing quality entails concentrating and enhancing the curriculum and teaching methods to ensure that students receive meaningful and effective education (Jayachandran, 2006; Rockoff &Turner, 2008; Hanushek & Woessmann, 2012). This includes updating textbooks, improving teacher training, and adopting modern pedagogical techniques. The consequences of healthcare investment for a growing population have far-reaching implications for both the health and economic well-being of societies, as they shape access to care, health outcomes, and overall quality of life (Baicker & Chandra, 2004; Jayachandran & Lleras-Muney, 2009).

The relationship between human capital development and economic growth is complex and multifaceted, as empirical studies have produced conflicting results, with some highlighting a positive impact and others revealing negative or ambiguous effects, necessitating a comprehensive examination of the various dimensions and factors at play. Investing in human capital through education, training, and skills development is essential for fostering economic growth by increasing labor productivity, fostering innovation, adapting to technological changes, encouraging entrepreneurship, and reducing social and economic inequalities (Miyanda & Venkatesh, 2017; Oluwadamilola *et al*, 2018; Akaakohol & Ijirshar, 2018). Conversely, the literature reveals that a high level of human capital development in one country could lead to a "brain drain" phenomenon, where highly skilled individuals emigrate to countries with better economic opportunities. This can result in a loss of talent and skills for the country of origin (Beine *et al*., 2008; Docquier & Rapoport, 2012). In addition, the pursuit of higher education often comes with significant costs and student loan debt, which can act as a financial burden for individuals and households. This debt burden can lead to reduced consumer spending, delaying economic growth (Dynarski, 2017; Looney& Yannelis, 2015).

A perusal of the literature reviewed above produces mixed and contradictory results concerning the relationships among population growth, human capital development and economic growth. These studies explored only the direct relationship between population growth or economic growth alone or between human capital development and economic growth. However, in economic theory, population growth has a transmission effect on economic growth through human capital development (Mankiw *et al*., 1992). Therefore, this study examined the indirect (transmission) effect of population growth on economic growth, with human capital development serving as a mediating variable. The study also seeks to investigate the moderating (combined) effect of population growth and human capital on economic growth in Nigeria.

3. Methodology

Data and Variables

The study utilized time series data spanning from 1983--2022. The period was considered adequate for examining regime change(s), political choices and institutional quality used for developing and managing the growth of the Nigerian population and human capital development, as they affect economic growth in Nigeria. Furthermore, in 1986, the structural adjustment programme (SAP) was introduced, which caused major structural changes in various economic variables (indicators), including human capital development issues and economic growth parameters. The study relied on secondary data sourced from the Central Bank of Nigeria (CBN) statistical bulletin and the World Bank Development Indicators. The main variables of interest include real gross domestic product (RGDP), a proxy for economic growth, the population growth rate (PGR), and the aggregate of government expenditures on education and health (GEA)}, which serve as indicators of human capital development. Other control variables that can explain insecurity, such as the unemployment rate (UR), foreign direct investment (FDI), and labor force participation (LFP), were also included in the study.

The study used real gross domestic product (RGDP) as a proxy for economic growth. The GDP is the monetary value of all goods and services produced in Nigeria in a particular year and any product taxes minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion of natural resources RGDP is calculated while accounting for inflation. Data on RGDP are obtained from the CBN Statistical bulletin. In this study, GDP is considered the dependent (explained) variable.

The population growth rate (PGR) is defined as the annual average rate of change in population size for a given country, territory, or geographic area during a specified period. It expresses the ratio between the annual increase in the population size and the total population for that year, usually multiplied by 100. The population growth rate is considered an independent variable for the study. These data are sourced from the CBN statistical bulletin. The expected sign of population growth is not clear. The expected sign for population growth is not clear. On the one hand, a growing population can expand the size of the labor force, which, if well employed, can lead to increased productivity and economic growth. More workers can mean increased production and a larger consumer base, potentially driving economic expansion (Bloom & Williamson, 1998). On the other hand, rapid population growth can strain natural resources, leading to resource depletion, environmental degradation, and increased competition for essential resources such as water and arable land. This can hinder economic growth and sustainability (Malthus, 1798). Government expenditures on education and health (GEEHs) are aggregated to serve as a proxy for human capital development in Nigeria. In this study, government expenditures on education entail actual expenditures (both capital and recurrent) geared toward the development of the educational sector in Nigeria. On the other hand, government expenditures on health entail all actual expenditures (both capital and recurrent) tailored toward the development of the health sector in Nigeria. The expected sign of these indices is positive, as increases in government expenditures (on both health and education) are expected to drive the growth of an economy.

Model specification

Essentially, this study is built from determinants of economic growth captured by the augmented version of the Solow–Swan model.

Y = F (K, L) ……3.1

where Y is output (or income), K is the stock of capital, and L is the labor force. Labor force participation (LAFp) is used to represent labor, RGDP is used for Y, foreign direct investment (FDI) is used for capital accumulation or composition. Thus, following the Mankiw, Romer and Weil (1992) augmented version of the Solow–Swan model, the modified form of the Cobb–Douglas function is

$Y = AK^{\alpha}H^{\beta}L^{1-\alpha-\beta}$ … … … … … … … … … … … … … … … … … … … 3.2

where α = elasticity of physical capital with respect to output and β = elasticity of human capital with respect to output.

In this extended model, human capital (H) is accumulated through investments in education and training, similar to the way physical capital (K) is accumulated through savings and investment. The inclusion of human capital allows for a more comprehensive explanation of economic growth,

accounting for the role of knowledge and skills in enhancing productivity and technological progress. The model excludes other variables, such as the labor force participation rate (LFPR) and foreign direct investment (FDI), to account for few variables that can be used to effectively examine the transmission effect of population growth to economic growth through human capital development.

The model is therefore specified as follows:

$lnRGDP=f\ (POGR,CD)$ -- ---------- - - - 3.3

where

RGDPP = Real GDP, a proxy for economic growth
POGR = Population growth rate
HCD = Human capital development (which combines the expenditures of the government of education and health).
ln = Natural logarithm

Converting the above equation to a stochastic form, it can be specified as follows:

$LnRGDP_t = \beta_0 + \beta_1 HCD_t + \beta_2 PGR_t$ 3.4

Essentially, the estimation of the SVAR begins with the specification of the reduced-form VAR, after which contemporaneous or short-run restrictions are imposed. The schematic form of the impact of population growth on economic growth through human capital development can be presented in line with the economic ordering of variables as

PGR → HCD → RGDP

PGR = population growth rate

HCD = Human capital development

RGDP = Real gross domestic product

The vector autoregressive (VAR) form of the model can be specified in a general form as

$A_0 = A_1 Y_{t-1} + \epsilon_t$ - - - - - - (3.5)

Modifying equation 3.5 to suit the present study, the models become:

$lnRGDP_t = \emptyset^1{}_{11} lnRGDP_{t-1} + \emptyset^1{}_{12} ln\mathrm{HCD}_{t-1} +$
$\emptyset^1{}_{13}\mathrm{PGR}_{t-1} + \emptyset^0{}_{12} ln\mathrm{HCD}_t + \emptyset^0{}_{13}\mathrm{PGR}_t + \mu_{1t} - - - - - -(3.6)$

$lnHCD_t = \emptyset^1{}_{21} lnRGDP_{t-1} + \emptyset^1{}_{22} ln\mathrm{HCD}_{t-1} +$
$\emptyset^1{}_{23}\mathrm{PGR}_{t-1} + \emptyset^0{}_{21} lnRGDP_t + \emptyset^0{}_{23}\mathrm{PGR}_t + \mu_{2t} - - - - - (3.7)$

$\mathrm{PGR}_t = \emptyset^1{}_{31} lnRGDP_{t-1} + \emptyset^1{}_{32} ln\mathrm{HCD}_{t-1} +$
$\emptyset^1{}_{33}\mathrm{PGR}_{t-1} + \emptyset^0{}_{31} lnRGDP_t + \emptyset^0{}_{32} ln\mathrm{HCD}_t + \mu_{3t} - - - -(3.8)$

When the SVAR model is used to account for the instantaneous effects and impose some restrictions, equation 3.8 becomes

$lnRGDP_t - \emptyset^0{}_{12} ln\mathrm{HCD}_t - \emptyset^0{}_{13}\mathrm{PGR}_t =$
$\emptyset^1{}_{11} lnRGDP_{t-1} + \emptyset^1{}_{12} ln\mathrm{HCD}_{t-1} +$
$\emptyset^1{}_{13}\mathrm{PGR}_{t-1} + \mu_{1t} -(3.9)$

$-\emptyset^0{}_{21} lnRGDP_t + ln\mathrm{HCD}_t - \emptyset^0{}_{23}\mathrm{PGR}_t =$
$\emptyset^1{}_{21} lnRGDP_{t-1} + \emptyset^1{}_{22} ln\mathrm{HCD}_{t-1} + \emptyset^1{}_{23}\mathrm{PGR}_{t-1} + \mu_{2t} - -(3.10)$

$$-\emptyset^{0}{}_{31} lnRGDP_t - \emptyset^{0}{}_{32} ln\mathrm{HCD}_t + \mathrm{PGR}_t = \emptyset^{1}{}_{31} lnRGDP_{t-1} + \emptyset^{1}{}_{32} ln\mathrm{HCD}_{t-1} + \emptyset^{1}{}_{33}\mathrm{PGR}_{t-1} + \mu_{3t} - -(3.11)$$

Expressing equations 3.9, 3.10, and 3.11 in matrix form, we have

$$\begin{Bmatrix} 1 & -\emptyset^{0}{}_{12} & -\emptyset^{0}{}_{13} \\ -\emptyset^{0}{}_{21} & 1 & -\emptyset^{0}{}_{23} \\ -\emptyset^{0}{}_{31} & -\emptyset^{0}{}_{32} & 1 \end{Bmatrix} \begin{Bmatrix} RGDP_t \\ HCD_t \\ PGR_t \end{Bmatrix} = \begin{Bmatrix} \emptyset^{1}{}_{11} & \emptyset^{1}{}_{12} & \emptyset^{1}{}_{13} \\ \emptyset^{1}{}_{21} & \emptyset^{1}{}_{22} & \emptyset^{1}{}_{23} \\ \emptyset^{1}{}_{31} & \emptyset^{1}{}_{32} & \emptyset^{1}{}_{33} \end{Bmatrix} \begin{Bmatrix} RGDP_{t-1} \\ HCD_{t-1} \\ PGR_{t-1} \end{Bmatrix} + \begin{Bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{Bmatrix}$$

Following the recursive approach, we can restrict the upper elements above the matrix diagonal to zero. That is, $\emptyset^{0}{}_{12} = \emptyset^{0}{}_{13} = \emptyset^{0}{}_{23} = 0$. Thus, the restricting parameters in A_0 yield:

$$\begin{Bmatrix} 1 & 0 & 0 \\ -\emptyset^{0}{}_{21} & 1 & 0 \\ -\emptyset^{0}{}_{31} & -\emptyset^{0}{}_{32} & 1 \end{Bmatrix} \begin{Bmatrix} RGDP_t \\ HCD_t \\ PGR_t \end{Bmatrix} = \begin{Bmatrix} \emptyset^{1}{}_{11} & \emptyset^{1}{}_{12} & \emptyset^{1}{}_{13} \\ \emptyset^{1}{}_{21} & \emptyset^{1}{}_{22} & \emptyset^{1}{}_{23} \\ \emptyset^{1}{}_{31} & \emptyset^{1}{}_{32} & \emptyset^{1}{}_{33} \end{Bmatrix} \begin{Bmatrix} RGDP_{t-1} \\ HCD_{t-1} \\ PGR_{t-1} \end{Bmatrix} + \begin{Bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{Bmatrix}$$

Justification for Restrictions

Building on the Solow–Swan growth model and the core principles of our research, we impose the restriction that human capital development (HCD) does not contemporaneously affect real economic growth (RGDP). Our study revealed that HCD plays a pivotal role in stimulating economic growth, but this relationship involves a time lag. HCD requires a gestation period before it translates into increased productivity and, consequently, economic

growth. Our restriction reflects the theoretical expectation that HCD's impact on RGDP is not immediate but delayed, aligning with the temporal dynamics inherent in human capital accumulation.

Similarly, we restrict the contemporaneous effect of population growth (PGR) on real economic growth (RGDP). This restriction is consistent with our research framework, which posits that the primary pathway for the influence of population growth on economic growth is mediated through its effect on human capital development (HCD). PGR alone is unlikely to lead to immediate economic growth. Therefore, we impose a restriction reflecting the theoretical assumption that the RGDP does not instantaneously respond to changes in population growth but rather responds with a time delay.

Similarly, existing economic literature suggests that population growth (PGR) does not contemporaneously influence human capital development (HCD). It is well established that the causal link between population growth and human capital development is not immediate. Theoretically, population growth drives the demand for investments in education, healthcare, and skill development, which take time to yield a productive and skilled labor force. This delay aligns with the time required for the effects of PGR on HCD to materialize.

Method of Data Analysis

The data analysis in this study involved a combination of descriptive statistics and econometric techniques tailored to examine the interplay between population growth, human capital development, and economic growth in Nigeria. Ensuring stationarity is critical in time series analysis, as it forms the foundation for meaningful econometric modeling. To establish the stationarity of the time series data, the Kwiatkowski, Philip Schmids, and Shin (KPSS) tests were employed. Recognizing the sensitivity of the results to the choice of lag length in the econometric models, lag length selection was conducted. To determine the appropriate lag length for the models, information criteria such as the Schwarz information criterion (SIC), Akaike

information criterion (AIC), and Hannan-Quinn were employed. The optimal lag length selection ensures the accuracy and reliability of the econometric analysis. The core analytical technique adopted in this study is the structural vector autoregressive (SVAR) model. This model was chosen for its capacity to account for direct and indirect effects and transmission mechanisms among the study variables. Specifically, the SVAR model enables the examination of how population growth influences economic growth through the intermediary role of human capital development. Within the SVAR framework, the study employed impulse response functions (IRFs) and variance decompositions (VDs) to reveal the dynamics of the responses among the variables. IRFs track the responsiveness of the variables to shocks from each other, shedding light on the short- and long-term interactions. VDs, on the other hand, offered insights into the proportion of movements in the dependent variables that can be attributed to their own shocks compared with shocks from other factors. These tools were essential in understanding the transmission effects in our research context.

4. Results and Discussion

Unit Root Test Results

The study utilized the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root test to examine the stationarity and determine the integration order of the variables. The results of the KPSS unit root test are presented in the table below.

Table 1: Results of the KPSS unit root test

Variables	MZa	Critical Value @5%	Order
LRGDP	0.790479	0.463000	Nonstationary
D(RGDP)	0.257860	0.463000	I(1)
PGR	0.835306	0.463000	Not stationary
D(PGR)	0.278792	0.463000	I(1)
LHCD	0.775385	0.463000	Nonstationary
D(LHCD)	0.316127	0.463000	I(1)

Source: Extracts from E-views Output

The results of the KPSS unit root test revealed that the log of real gross domestic product (LRGDP), log of human capital development (LRGDP) and population growth rate (PGR) were not stationary at all levels but became stationary at the first difference. This is because their Kwiatkowski–Phillips–Schmidt–Shin statistics (0.257860, 0.316127 and 0.278792) were less than the critical value of 0.463000. This accounts for the use of the VAR model to examine the relationships among the study variables.

To ensure the robustness of the results obtained from the KPSS unit root test, the augmented Dickey–Fuller (ADF) test is also employed as a complementary diagnostic tool. This helps confirm the stationarity of the variables at their first differences, thus providing additional validation for the application of the VAR model in examining the relationships among the study variables. The results of the ADF test are presented in Table 2.

Table 2: Results of the ADF unit root test

Variable	Statistic	Crit. Value @5%	Prob.	Order
LRGDP	1.509934	2.936942	0.5184	Nonstationary
D(LRGDP)	3.388423	2.936942	0.0173	I(1)
PGR	2.342018	2.938987	0.1645	Nonstationary
D(PGR)	2.397734	1.949319	0.0177	I(1)
LHCD	1.297129	2.936942	0.6216	Nonstationary
D(LHCD)	8.597134	2.936942	0.0000	I(1)

Source: Extracts from E-views Output

Table 2 confirms that all the variables are stationary at their first difference. This further validates the earlier results, indicating that none of the variables exhibit unit roots at their first difference, thus meeting the stationarity requirement for further analysis via the VAR model.

VAR Lag Order Selection Criteria

The results of the VAR lag selection criteria are presented in Table 2. These criteria serve as tests to identify the optimal lag, ensuring the generation of robust and reliable estimates.

Table 3: VAR Lag-Order Selection Results

Lag	LogL	LR	FPE	AIC	SC	HQ
	-67.39024	NA	0.007418	3.609756	3.737722	3.655669
1	101.8922	303.8403	2.00e-06	-4.609857	-4.097991	-4.426204
2	125.4828	38.71286*	9.57e-07*	-5.358095*	-4.462331*	-5.036702*
3	131.9069	9.553715	1.12e-06	-5.225995	-3.946332	-4.766863

Source: *Extracts from E-views Output*

* indicates lag order selected by the various criteria, i.e.,
LR: sequential modified LR test statistic (each test at the 5% level),
FPE: final prediction error,
AIC: Akaike information criterion,
SC: Schwarz information criterion and
HQ: Hannan–Quinn information criterion.

The results presented in Table 3 indicate that lag two (2) has the lowest LR, FPE, AIC, SC and HQ relative to the other lags. This means that, considering all the criteria (LR, FPE, AIC, SC, and HQ), lag two (2) performs the best in terms of model fit and complexity. Henceforth, lag 2 will be employed consistently during the entire estimation and analysis.

Table 4: Correlation test results

	LNRGDP	LNHCD	PGR
LNRGDP	1	0.146408	0.077593
LNHCD	0.146408	1	0.103302
PGR	0.O77593	0.103302	1

Source: *Extracted from E-views 10 output*

Table 4 presents the results of the correlation test among the variables LNRGDP (natural logarithm of real gross domestic product), LNHCD (natural logarithm of human capital development), and PGR (population growth rate). The correlation coefficients depicted in the table, namely, 0.146408, 0.077593, and 0.103302, reveal that the variables exhibit low correlations, all being below 0.8. This finding is significant, as it suggests the absence of multicollinearity concerns within the variables considered for the study. Consequently, this implies a lack of correlation that could lead to a single equation matrix, mitigating the issue of high multicollinearity in the analysis.

The transmission Effect of Population Growth on Economic Growth Through Human Capital Development in Nigeria

Given the inherent unreliability of the standard errors associated with unstandardized VAR estimates, this study relies on impulse response and variance decomposition analyses. However, it is crucial to underscore the significance of examining the contemporaneous responses of the variables to their own shocks and shocks in other variables. Notably, the study imposes restrictions on the immediate effects of population growth and human capital development on economic growth, as well as population growth on human capital development. These restrictions could stem from a theoretical stance that changes in population growth and human capital development take time to materialize and manifest in overall economic growth and that rapid changes in population growth may not have an immediate, direct impact on human capital development.

In light of these restrictions, the structural VAR estimates specifically focus on evaluating the contemporaneous effects pertaining to the responses of tax revenue to shocks in economic growth and domestic investment. Additionally, attention is given to assessing the response of domestic investment to shocks in economic growth. This recursive approach allows for a detailed examination of the relationships and interdependencies among the variables, providing a more comprehensive understanding of the dynamics at play in the context of Nigeria's economic landscape. The results of the SVAR contemporaneous effects are presented in Table 5.

Table 5: Contemporaneous effects

	RGDP	**HCD**	**PGR**
RGDP	1	0	0
HCD	-0.40238 (0.6952)	1	0
PGR	-0.02905 (0.2228)	0.00218 (0.5561)	1

Source: Extracts from E-views Output

Table 5 presents the contemporaneous effects of the variables for the study. The table shows the estimates of the unrestricted short-run effects with their corresponding probabilities enclosed in parenthesis. The matrix of contemporaneous effects indicates that the instantaneous effect of economic growth on population growth is negative but statistically insignificant at the 5% level. that immediate economic advancements may not directly translate into a substantial reduction in population growth. This result partially aligns with those of Gayal & Dangayach (2015) and Khawaja & Din (2014), who reported that economic growth has a negative effect on population growth, especially in the short run. The table also shows that right away, there is a negative effect of economic growth on human capital development in Nigeria. The effect, however, is not statistically significant at the 5% level. This implies that in the short run, the Nigerian government or private sector has paid more attention to other aspects of economic growth, such as infrastructure development or industrialization, than to human capital development. This could be evidenced by the disproportionate budg*et al*location to the education sector. Thus, the observed negative effect on human capital development might be due to resource allocation choices made in the initial stages of economic growth. These findings contrast with those of Agujiuba and Adeniyi (2013), who reported a positive relationship between human capital development and economic growth in Nigeria. The table also indicates that the contemporaneous effect of human capital development on population growth is positive but statistically insignificant at the 5% level. This could be understood from the perspective that, in Nigeria, investments in human capital, such as education and healthcare, require some lags to influence demographic trends. The positive impact on population growth might become more evident in the medium to long term, and the short-term effect may not be statistically significant.

Impulse response function

The results of the impulse response of real gross domestic product, human capital development, and population growth to shocks in other variables are presented in Figures 1, 2 and 3.

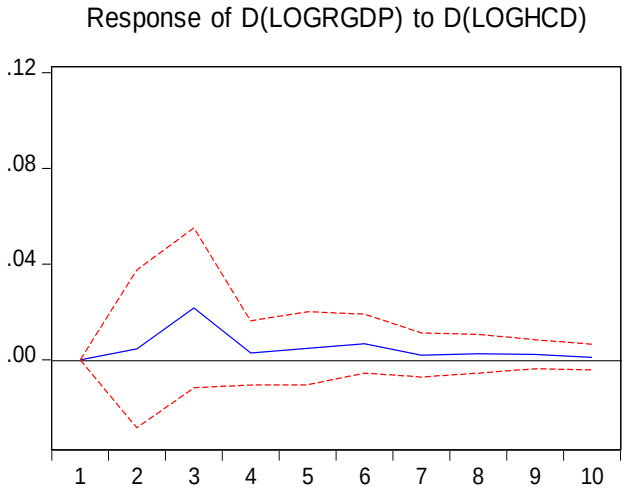

Fig. 1: Response of economic growth to shocks in human capital development

Figure 1 represents the response of economic growth to one standard deviation shocks in human capital development. The figure shows that economic growth responds positively to one standard deviation shocks in human capital development throughout the forecast period. The figure further indicates that initially, economic growth responds slowly to shocks in human capital development. This response is, however, observed to reach its peak in the third year, after which the response declines to the fourth year and asymptotically becomes zero for the remaining forecast period. The initial slow response followed by a peak in the third year and the positive response of economic growth to human capital development shocks suggest that investing in the education and skill development of the workforce has long-term economic benefits.

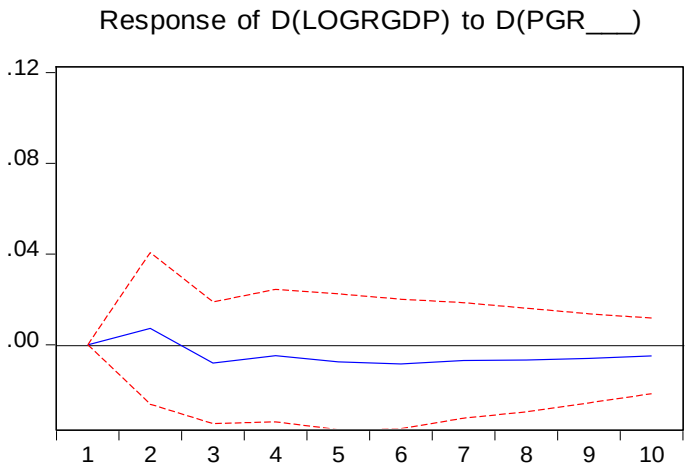

Fig. 2: ***Response of economic growth to population growth shocks***

Figure 2 depicts the response of economic growth to a one standard deviation shock in population growth. The figure indicates that in the short run, economic growth responds positively to shocks in the population up to the second year and thereafter decreases and reverts to a negative response throughout the forecast period. This implies that, initially, as the population grows, there might be an increase in the labor force, contributing positively to economic output in Nigeria. However, as the population continues to grow, additional labor may face diminishing marginal returns, leading to a decline in the positive impact on economic growth. This is consistent with Malthusian theory. According to Malthus, as the population increases, the law of diminishing returns sets in. Additional people may contribute to increased labor supply, but the marginal productivity of each additional person declines, leading to diminishing returns in terms of economic output.

Moreover, this result is consistent with the idea that the population is a double-edged sword. While an expanding population can contribute to economic activity, the challenges associated with sustaining growth may outweigh the benefits.

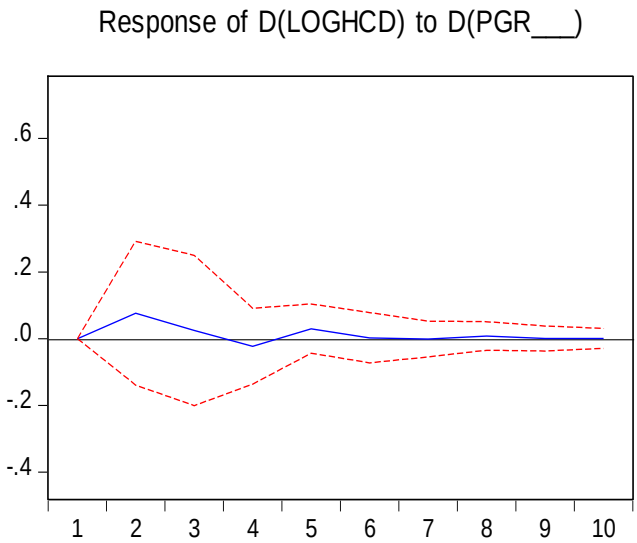

Figure 3: The impulse response of human capital development to shocks in population growth

Figure 3 above shows the response of human capital development to a one standard deviation shock in population growth. The figure reveals that the response positively increases up to the second year of the forecast period. This could be attributed to factors such as an expanding labor force, increased demand for skills, or investments in education and training in response to a growing population. Thereafter, the response of human capital would decline slowly and become slightly negative in the fourth year. The response, however, would slowly revert to positive and become zero in the long run. This implies that, over time, the negative impact is mitigated, and the response becomes either positive or neutral.

From the analysis above, tracing the transmission effect of population growth on economic growth through human capital development is easy. Economic theory holds that population growth positively impacts economic growth. This is potentially through a number of channels, such as an increased labor force, increased tax base, and market expansion. For example, a larger workforce can lead

to increased productivity and output in the economy, assuming that employment opportunities and labor market absorption are effectively managed. Human capital development emerges as the crucial intermediary in this transmission process. The increased population prompts a positive response in human capital development, possibly due to the demand for skills and education. As human capital development increases in response to population growth, it positively influences economic growth through factors such as enhanced productivity and innovation.

Variance decomposition

The Accumulated Forecast Error Variance of Economic Growth in Nigeria

The results of the accumulated forecast error variance of economic growth to its own shocks and those of human capital development and population growth in Nigeria are summarized and presented in Table 6.

Table 6: Variance decomposition of economic growth in Nigeria

Period	**LNRGDP**	**LNHCD**	**PGR**
Initial Period	100%	0.00%	0.00%
Short-run (Third year)	95.514%	3.633%	0.853%
Long-run (10th year)	93.208%	3.961%	2.831%
Decision	**Decreasing**	**Increasing**	**Increasing**

Source: Extracts from E-views Output

The results in Table 6 suggest that the initial shock, 100% of the variation in economic growth, was attributable to one's own shock and that no variation in economic growth was attributable to a shock in human capital development and population growth. In the short run, economic growth (LNRGDP) still accounts for the majority of the variance (95.514%), but there are small contributions from human capital development (3.633%) and population growth (0.853%). This suggests that, over the short run, human capital development and population growth start to play a role in explaining the variability in economic growth. Economic growth continues to be the dominant

factor, but there are increased contributions from both human capital development (3.961%) and population growth (2.831%). This finding indicates that, over the long run, human capital development and population growth become more significant in explaining the variation in economic growth. The study therefore infers that variance in economic growth to own shocks or innovations is expected to decline over time, whereas those contributions to human capital development and population growth are expected to increase over the forecast period.

Table 7: Variance decomposition of human capital development in Nigeria

Period	**LNRGDP**	**LNHCD**	**PGR**
Initial Period	0.39%	99.61%	0.00%
Short-run (Third year)	17.01%	81.90%	1.09%
Long-run (10th year)	17.25%	81.45%	1.30%
Decision	**Increasing**	**Decreasing**	**Increasing**

Source: Extracts from E-views Output

The results in Table 7 indicate that, initially, almost all of the variance in human capital development is attributed to itself (99.61%), with a small contribution from economic growth (0.39%). In the short run, there is a notable increase in the contribution of economic growth (17.01%) to the variance in human capital development. However, human capital development itself remains the dominant contributor (81.90%), with a minor contribution from the population growth rate (1.09%).

The forecast also reveals that the pattern persists in the long run. Economic growth contributes slightly more (17.25%), but human capital development continues to be the primary driver (81.45%), with a small contribution from the population growth rate (1.30%).

One can therefore infer from Table 7 that the changes in human capital development due to own shocks would decline over time, whereas those due to shocks in economic growth and population growth would increase over time.

Table 8: Variance decomposition of population growth in Nigeria

Period	LNRGDP	LNHCD	PGR
Initial Period	3.44%	0.85%	95.71%
Short-run (Third year)	4.44%	4.48%	91.09%
Long-run (10th year)	11.18%	3.97%	84.84%
Decision	**Increasing**	**Decreasing**	**Decreasing**

Source: Extracts from E-views Output

The results in Table 8 show that in the initial period, a significant portion of the variance in the population growth rate is attributed to itself (95.71%), with smaller contributions from economic growth (3.44%) and human capital development (0.85%). The economic implication is that during the initial period under consideration, changes in the population growth rate are largely driven by factors intrinsic to the population, such as birth rates, death rates, and migration patterns. Over time (short run), there is a slight increase in the contributions from economic growth (4.44%) and human capital development (4.48%). However, the population growth rate remains the dominant factor (91.09%). The table further reveals that in the long run, the contribution of economic growth continues to increase (11.18%), whereas the contributions of human capital development and population growth to the variance in population growth decline. The decline in the contribution of human capital development to the variation in population growth could be attributed to cultural and social factors. Cultural and social factors, which play significant roles in family dynamics and fertility choices, may evolve over time. Cultural shifts, such as increased emphasis on smaller family sizes or delayed childbearing, can influence population growth independently of human capital development.

Table 9: Diagnostic test results

Test	Statistic	Probability
Ramsey RESET	1.174259	0.3017
Residual normality	1.544923	0.461875
Breusch-Godfrey heteroscedasticity	1.009682	0.5126
LM Serial Correlation,	1.187265	0.6736

Extracts from E-views Output

On the basis of the information presented in Table 9, the test statistics employed to assess serial correlation and heteroskedasticity, along with their corresponding probability values, suggest a lack of compelling evidence to reject the null hypotheses. This implies an absence of serial correlation and heteroskedasticity. Additionally, the residual normality test indicates that the residuals conform to the classical assumption of ordinary least squares, likely yielding unbiased results. This is substantiated by the normality test's probability value (0.461875), which exceeds the 5% threshold.

5. Conclusion and policy recommendations

The study concluded that there is an insignificant negative instantaneous effect of economic growth on population growth and human capital development in Nigeria. The study also shows that there is a shifting landscape over time, with human capital development and population growth gaining increased significance in explaining Nigeria's economic growth variations in the long run. Moreover, regarding the transmission effects of population growth and human capital development on economic growth, the study concluded that there is a positive effect of population growth on Nigeria's economic growth through human capital. However, this positive effect materializes only in the long run.

On the basis of the findings of the study, the following recommendations were provided:

i. Given the insignificant negative instantaneous effect of economic growth on both population growth and human capital development, there is a need to reassess resource allocation

strategies. Policymakers in Nigeria should consider rebalancing budg*et al*locations to ensure a more equitable distribution between economic development, human capital initiatives, and infrastructure projects.

ii. The increasing significance of human capital development in explaining economic growth in the long run suggests a need for sustained investment in education, skills, and healthcare. The government at all levels should develop and implement comprehensive, long-term strategies to increase the quality of education, vocational training, and healthcare services, fostering a skilled and healthy workforce over time.

iii. Furthermore, to acknowledge the positive long-term effect of population growth on economic growth through human capital, policymakers should design and implement population policies that promote family planning and maternal and child healthcare and address cultural factors influencing fertility choices, ensuring sustainable demographic trends.

iv. The government and nongovernmental and private institutions should be key to organizing public awareness campaigns to educate the populace about the long-term benefits of family planning, education, and healthcare for economic development.

v. Finally, there is a need for the Nigerian government to foster international collaboration and knowledge exchange with countries facing similar demographic and economic challenges to share best practices and lessons learned about the interplay of population, human capital development and economic growth.

References

Alvarez-De-Toledo, P., Crespo Marquez, A., Núñez, F., & Usabiaga, C. (2008). Introducing VAR and SVAR predictions in system dynamics models. *International Journal of Simulation and Process Modelling*, 4(1), 7–17.

Baicker, K., & Chandra, A. (2004). Medicare spending, the physician workforce, and beneficiaries' quality of care. *Health Affairs*, 23(Suppl1), W4-184-W4-197.

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. University of Chicago Press.

Beine, M., Docquier, F., & Rapoport, H. (2008). Brain drain and human capital formation in developing countries: Winners and losers. *Economic Journal*, 118(528), 631-652.

Blaug, M. (1976). Economic man: A portrait from the social sciences. *Journal of Economic Literature*, 14(3), 827-840.

Bloom, D. E., & Williamson, J. G. (1998). Demographic transitions and economic miracles in emerging Asia. *World Bank Economic Review*, 12(3), 419-455.

Bloom, D. E., Canning, D., & Sevilla, J. (2003). *The demographic dividend: A new perspective on the economic consequences of population change*. RAND Corporation.

Docquier, F., & Rapoport, H. (2012). Globalization, brain drain, and development. *Journal of Economic Literature*, 50(3), 681-730.

Duflo, E., Dupas, P., & Kremer, M. (2015). Education, HIV, and early fertility: Experimental evidence from Kenya. *American Economic Review*, 105(9), 2757-2797.

Dynarski, S. M. (2017). Is a student loan crisis on the horizon? *Brookings Papers on Economic Activity*, 48(1), 1-89.

Ehrlich, P. R., & Holdren, J. P. (1971). Impact of population growth. *Science*, 171(3977), 1212-1217.

Foucault, M. (2010). The making of Homo Economicus: The concept of rationality, the actor, and the economic system. *Journal of Economic Thought*, 45(2), 293-306.

Garza-Rodriguez, J., Andrade-Velasco, C. I., Martinez-Silva, K. D., Renteria-Rodriguez, F. D., & Vallejo-Castillo, P. A. (2016). The relationship between population growth and economic growth in Mexico. *International Journal of Economics and Social Sciences*, 9(4), 23-32.

Guga, K., Alikaj, L., & Zeneli, F. (2015). Population, economic growth, and development in emerging economies. *European Scientific Journal*, 11(10), 82-93.

Hanushek, E. A., & Woessmann, L. (2012). Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation. *Journal of Economic Growth*, 17(4), 267-321.

Jayachandran, S. (2006). Selling labor low: Wage responses to productivity shocks in developing countries. *Journal of Political Economy*, 114(3), 538-575.

Jayachandran, S., & Lleras-Muney, A. (2009). Life expectancy and human capital investments: Evidence from maternal mortality declines. *The Quarterly Journal of Economics*, 124(1), 349-397.

Kremer, M., & Miguel, E. (2007). The illusion of sustainability. *The Quarterly Journal of Economics*, 122(3), 1007-1065.

Kuznets, S. (1934). *National income, 1929-1932* (73rd Congress, 2nd Session, Senate Document No. 124). U.S. Government Printing Office.

Looney, A., & Yannelis, C. (2015). A crisis in student loans? How changes in the characteristics of borrowers and in the institutions they attended contributed to rising loan defaults. *Brookings Papers on Economic Activity*, 2015(1), 1-89.

Malthus, T. R. (1798). *An essay on the principle of population*. J. Johnson.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, 107(2), 407-437.

Mincer, J. (1974). *The economic theory of human capital*. Columbia University Press.

Muralidharan, K., & Sundararaman, V. (2011). Teacher performance pay: Experimental evidence from India. *Journal of Political Economy*, 119(1), 39-77.

Rockoff, J. E., & Turner, L. A. (2008). Going to school on teachers. *The Journal of Human Resources*, 43(4), 871-894.

Statman, M. (1987). Imperfect information and investor heterogeneity as determinants of household portfolio selection. *Journal of Finance*, 42(2), 381-393.

Thaler, R. H., & Mullainathan, S. (2000). The behavioral economics of education: A survey. *Journal of Economic Perspectives*, 14(1), 189-211.

World Bank. (2021). *World development indicators 2021*. Washington, DC: World Bank.