Effects of Population Dynamics on Economic Growth Among the World Most Populous Countries

Oyedepo, Elizabeth Omolola,[†] Obayelu, Abiodun Elijah[§] & Owuru, Joel Ede[‡]

Abstract

High population growth is a growing concern throughout the world and a challenge to any country's economy. This study assessed the effects of population growth rate on economic growth among four most populous countries of the world namely China, India, United States of America and Nigeria. Time series data from the World Development Indicators spanning from 1991- 2020 were used. Autoregressive Distributed Lag (ARDL) model was used for the analysis and results revealed that in the long-run total population growth was negatively related with economic growth in all the four countries. However, in Nigeria, change in working age population, sectoral employment (proxy for human resource utilization) and trade openness had significant positive effects on economic growth both in the long-run and short-run. In India, China and the United States, change in working age share had no effect on economic growth in the long-run but in China and India, there is evidence of significant positive effects in the short-run. Furthermore, in China and the U.S, the initial share of working age in the population had positive long run effects on economic growth. The study concludes that improvement in the working age share in each of the selected countries will boost economic growth but an increase in the overall population will have detrimental effects on the growth of the economy. Policies necessary to increase the share of working age in the population is therefore recommended as a way to improve economic growth in these countries.

Keywords: Population dynamics; Vector Auto-regression; Working age share; Populous countries

JEL Classification Codes: F43, O40, O47, O57

[†] Department of Economics,Faculty of Humanities, Management and Social Sciences, Augustine University, Ilara – Epe, Lagos State, Nigeria. Corresponding author 's email; lolaoyedepo1@gmail.com

[§] Department of Agricultural Economics and Farm Management, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

[‡] Department of Economics,Faculty of Humanities, Management and Social Sciences, Augustine University, Ilara – Epe, Lagos State, Nigeria.

1.0   Introduction

Population growth is an increase in the number of people in a given area and its relationships with economic growth varies across countries. It has remained a key issue facing developing economies in the world (Adeosun and Popogbe, 2021). One of the most prominent theories of population growth is that of Malthus, which states that population growth contributes negatively to per capita income and deteriorates human development index. Population dynamics of an economy have serious implications on the economic growth and the overall welfare of a people. Studies on population growth are relevant now and in the next few decades to come. In 2012, world population was just about 7 billion people (Martin *et al*., 2021; New York Times, 2012); but today records show that world population has increased tremendously and is armed with potentials for further increase in the future. Recent estimates according to a United Nations report revealed that the world population has now reached 7.9 billion as of January 2022 (World Population Clock, 2022; World Population Review, 2021).

Economic analysts and population study experts have also asserted that world population is sure to continue to rapidly expand over the next few decades taxing natural resources, and with other negative implications on economic development if countries cannot better manage the growth (United Nations Report, 2021). Drummond *et al.*, (2014) noted that "About 80% of the projected 4 billion increase in global population will be accounted for by Africa in 2100". Many developing countries are currently experiencing high population growth due to high fertility rates and declining death rates.

In the past, many countries of the world have regarded population growth and explosion as detrimental and a hindrance to economic growth and inimical to the improvement in the overall life of a people. In fact, many policy reviews on population have identified the negative influence of population dynamics on economic development of some countries of the world. However, recent studies reveal that population explosion can be a blessing rather than a curse as great benefits can be obtained from population growth if harnessed properly (Wesley and Peterson, 2017; Bloom *et al.,* 2003).

There are a number of well-known and well-developed theories that relate population growth and income levels from the original Malthusian hypotheses to the more recent Kremerian model. These theories give a clear-cut way of thinking about the relationship between these two variables of key economic relevance. However, empirical works are lagging behind, and there is very little as far as we know on systematic evidence on the relationship. This paper therefore compared the effects of population growth rate on economic growth of four (4) most populous countries of the world namely China, India, United States of America and Nigeria. Findings in this study will provide a reliable input for formulating development policies in these countries.

The remainder of this study is organized as follows; Section 2 reviews the literature on the relationship between population growth and economic growth in the selected countries. Section 3, hosts the methodology for the study while sections 4 and 5 presents the results and discussion and also the conclusion and recommendations for the study.

2.0   Literature Review

2.1   Relationship between Population Growth and Economic Growth

Population growth is known to affect many dimensions of a people such as the age structure of a country's population, international migration, economic inequality, and the size of a country's work force. All these factors both affect and are affected by the overall economic growth in a country. There is an extensive literature on these relationships but little consensus on the actual effects of population on economic growth (Heady & Hodge, 2009; Solow, 1956).

In a study on population and economic growth, Piketty (2014) stated that "economic growth always includes a purely demographic component and a purely economic component and only the economic component allows for an improvement in the standard of living".

Bloom *et al.*, (2003) however concluded his research by "shedding more light on the debate over the impact of population dynamics on economic development and in particular the importance of age structure in determining economic growth. He noted that the age structure of the population (that is, the way a nation's population is distributed across different age groups) does influence economic growth if its innate potentials are properly employed. Furthermore, in his report, he explained that individual economic behavior varies at different stages of life, and as such changes in age structure can significantly affect national economic performance. Nations with a high proportion of young or old dependents tend to devote a relatively high proportion of resources to these groups, and this often limits economic growth".

By contrast, nations in which a relatively large share of the population has reached the prime ages for working and saving may enjoy a boost to income growth obtained from the higher share of the population that is working, from the accelerated accumulation of capital, and from reduced spending on dependents. This phenomenon is known as the "demographic dividend." The combined effect of this "dividend" and effective policies in other areas of an economy can stimulate economic growth (Bloom *et al.*, 2003).

Some developed countries of the world are currently experiencing slow population growth due to declining fertility rates. "Many policy analysts believe that economic growth in these high-income countries is likely to be relatively slow in years to come due to the falling population growth rate recorded in recent years" (Baker, Delong, & Krugman, 2005).

Furthermore, Piketty (2014) also speculates that economic growth is likely to be relatively slow in the future especially less than the rate of return to capital in these countries experiencing slow population growth. The slow population growth will however be vastly recorded in the developed countries. Buttressing this fact, Baker *et al.,* (2005) noted that the slow population growth in the United States is part of the reason why future U.S. economic growth will be lower in future than what it is today. In support of this new development, Peterson (2017) also affirmed that "low population in high income countries are likely to create social and economic problems, while high population in low-income countries may slow down their development.

Some economic experts have suggested international migration to correct problems of population dynamics though many economic analysts have opposed this. "Others argue that population growth has been and will continue to be problematic as more people use more of the finite resources available on earth, thereby reducing long-term potential growth "(Linden, 2017).

The relationship between population growth and economic growth has been studied extensively over the years and is generally accepted to be controversial and generally inconclusive (Klasen and Lawson, 2007; Heady and Hodge, 2009; Eze and Eze, 2014; Guga, Alikaj and Zeneli, 2015; Aidi, et al., 2016; Ngwudiobu,2016; Wesley and Peterson 2017; Mesagan *et al.*, 2018; Alimi *et al.*, 2021).

Some authors (such as: Degu, 2019; Loiboo, Luvanda and Osoro, 2021) offer theoretical arguments and empirical evidence to show the links between population growth and economic growth. The first theory on population and economic growth states that population growth stimulates economic growth, the second theory views population growth as a factor that adversely affects economic growth. The third school of thought posits that population growth is a neutral factor in economic growth, and is determined outside standard growth models.

Eze and Eze (2014) investigated the effects of an increase in population on growth in the economy. The study used GDP growth per capita in lieu of economic growth. ARDL test to Cointegration was used for the analysis. The study revealed a long-run sustainable equilibrium between economic growth and population growth through the use of the ARDL. The study again revealed a unidirectional causality between the population and the economic growth through the use of the pairwise Granger Causality test technique.

2.2 World's Most Populous Countries and Economic Growth Rate

According to a 2021 World Population Review report, the seven most populous countries of the world are China, India, United States, Indonesia, Pakistan, Brazil and Nigeria with population estimates of 1.444 billion, 1.393 billion, 332 million, 276 million, 225 million, 213 million and 211 million people respectively. However, their population growth rate varies as China the most populous country of the world has a population growth rate of 0.34% while India, the United States, Indonesia, Pakistan and Brazil has population growth rate of 0.97%, 0.58%, 1.04%, 1.95% and 0.67% respectively. Nigeria is the most populous country in Africa and it has a population growth rate of 2.55% (World Population Review, 2021).

In terms of economic growth rate, a recent international report on world economic outlook for the year 2021 revealed that GDP growth rate for China, India, U.S and Nigeria was 8.02 %, 9.50 %, 5.97 % and 2.64 % respectively. Another United Nations report also revealed that "The three largest economies in the world as measured by nominal GDP are the United States, China, and Japan" (United Nations Online Report, 2021; World Population Review, 2021).

A 2021 World Bank report of over 200 countries of the world revealed that on the basis of nominal GDP, United States ranked first with 20.49 trillion dollars, a per capita GDP of 66,678 dollars and a population of 332,915,073 people. China ranked second with a nominal GDP of 15.47 trillion dollars, a per capita GDP of 10,710 US dollars and a total population of 1, 444, 216, 107 people. India ranked fifth with a nominal GDP of 3.26 trillion dollars, a total population of 1,393,409,038

and a per capita GDP of 2,338 US dollar. However, Nigeria ranked 27th with a nominal GDP of 496.12 billion dollars, a per capita GDP of 2,347 US dollars and a total population of 211,400,708 people (World Bank, 2021; World Population Review, 2021).

However, in terms of per capita GDP among the four countries considered for this study; US ranked first with (66,678 US dollars), China ranked second with (10,710 US dollars), Nigeria ranked third with (2,347 US dollars) while India ranked fourth with (2,338 US dollars) (International Monetary Fund Report, 2021 World Population Review, 2021).

Furthermore, the reports reveal that largest economies in the world particularly in Europe have smaller populations. Such countries include the United Kingdom, Germany, France and Italy have been rated to be among the top ten largest economies of the world and all have population of under 100 million people. Some other extremely small countries such as Canada with about 36.5 million residents, Luxembourg and Monaco with fewer than a million residents are major economic players in the financial world than their population numbers would suggest (World Population Review, 2021; United Nations Online Report, 2021).

According to Odeh, (2010) "Global North countries are wealthy, technologically advanced, politically stable and aging as their societies tend towards zero population growth the opposite is the case with Global South countries. While Global South countries are agrarian based, dependent economically and politically on the Global North, the Global North has continued to dominate and direct the Global South in international trade and politics".

2.3 China's Demography and Economic Growth

China is currently the world's most populous country and has been the world's most populous nation for many centuries. Today China has about 18.47 % share of the world population with a population estimate of 1.44 billion people and a population growth rate of 0.34% (Wee, 2021; U. S Census Bureau, 2021, Worldometers, 2022). "China's demography typifies a country with a large population with a relatively small youth component explaining the reason for China's ageing population" (U.S Census Bureau – China, 2021). Population experts have forecasted that in just more than a decade to come, China will for the first time in its long history give up its title to India (Feng, 2010).

Over the last 40 years China has made rapid progress economically. This has been referred to as the "Asian miracle". Remarkable demographic changes in China resulted in her rise economically. "Observers of China's rise, when assessing the implications for global peace and prosperity, have largely focused their attention on the country's economy, on its energy and resource needs, on the environmental consequences of its rapid expansion, and on the nation's military buildup and strategic ambitions. Yet, underlying all these dazzling changes and monumental concerns is a driving force that has been seriously underappreciated: China's changing demography" (Feng, 2010; Xiaogang, (2015; Wang and Fu, 2017).

China nearly doubled in population from 540 million in 1949 to 969 million in 1979. By the end of 1982 the population reached 1 billion people. However, between 1982 and 2015, population growth slowed in China because of the one child policy instituted in 1979 (Banister, 1992). "The

one child policy was a highly ambitious population control program which employed a combination of public education and social pressure to achieve its aim of population reduction. The uniqueness of the policy is that it linked reproduction with economic cost or benefit in that it rewarded those who observed the policy and penalized those who did not" (Kuo Lily, 2019).

Through this policy, the rate of increasing population was drastically lowered after the penalties were made. Couples with only one child were given a "one-child certificate" entitling them to such benefits as cash bonuses, longer maternity leave, better child care, and preferential housing assignments. In return, they were required to pledge that they would not have more children (Kuo Lily, 2019).

China's population policy had tremendous effects on fertility reduction (Feng, 2010). The enactment of the population policy and the decline in mortality accelerated the demographic transition process. In summary, the success of the population control played an important role in lowering population growth rate such that the growth in food production can keep pace with the needs of the nation (Renkou, 1988).

China is the second-largest economy in the world. She has experienced an average growth rate of 9.52% between 1989 and 2019. The country is the second-largest economy considering nominal GDP, at $15.47 trillion, and the largest using GDP (PPP), which is $27.31 trillion. China has approximately $23 trillion in natural resources, 90% of which are rare earth metals and coal (Bucci, 2015; World Bank, 2012; World Bank, 2017; World Population Review, 2021).

The 1978 economic reform in China was a huge success and resulted in the rise in average economic growth from 6% to over 9%. The reform program emphasized the creation of private and rural businesses, easing the state regulations on prices, and investment in workforce education and industrial output. Another driving force behind the growth of China's economy is worker efficiency. China has been benefitting from demographic dividend for many years due to the larger working age share of the population contributing tremendously to its economic growth (World Bank Report 2021).

 "One of the secrets to economic development in China since the early 1990s is that it had a two-pronged approach to maintaining economic growth as its population shrank. Firstly, it slowed down the decline of the urban workforce by raising the retirement age and encouraging migration of more of the country's 510 million rural residents to cities. Secondly, it worked at raising productivity which is a measure of economic output per worker with the latest five-year plan over time emphasizing better vocational education and more investment in scientific research, automation and digital infrastructure" (Zhang, 1993).

2.4   India's Demography and Economic Growth

The second most populated country of the world with nearly a fifth of the world's population is India (United Nations Report, 2019). "According to the details in the 2019 revision of the World Population Prospects the population stood at 1,352,642,280 in 2019; In the year 2020, it grew to 1,393,409,038 and there are speculations that by the end of December 2021, India's population crossed 1.4 billion mark (Worldometer Clock, 2021).

Between the years 1975 and 2010, India's population doubled to 1.2 billion, reaching the one billion mark in 1998. There are accurate projections that by 2024, India will surpass China to become the world's most populous country (The Times of India, 2017). Further projections reveal it might be the first country to host about 1.5 billion people by 2030 and its population could reach 1.7 billion people by 2050 (Gladstone, 2015; United States Census Bureau, 2011). India's population structure reveals a relatively young population with more than 50% of its population below the age of 25 and more than 65% below the age of 35. "In 2020, the average age of an Indian was 29 years, compared to 37 for China and 48 for Japan (World Data, 2021).

"India's economy is the fifth-largest in the world overtaking the UK and France in 2019 to take the fifth spot. However, due to India's high population, India's GDP per capita is $2,338 while that of US is 66,678 US dollars (World Bank Data, 2021; World Population Review, 2021). "India once operated a closed economy with previous autarkic policies but today it's developing into an open – market economy. The country's economic liberalization began in the very early 1990s and included reduced control of foreign trade and investment, industrial deregulation, and privatization of state-owned enterprises. These measures have helped India accelerate economic growth. India's service sector is the fastest-growing sector in the world accounting for 60% of the economy and 28% of employment. Manufacturing and agriculture are two other significant sectors of the economy "(World Bank Data, 2021).

2.5 United States' Demography and Economic Growth
The official resident population of the United States according to the US Census Bureau as of 2020 is about 330 million. "The United States is the third most populous country of the world (Population Clock, 2020). "The total fertility rate in the United States estimated for 2020 is 1.638 children per woman (Martin et al., 2021). The rapid increase in population growth in the US is due to the foreign-born immigration over the years. Records show that foreign- born population doubled from almost 20 million in 1990 to over 45 million in 2015 and this represents a one – third population increase (Hispanic Trend Project, 2015).

The United States has been and is currently still the world's largest economy since 1871. As of 2021, the nominal GDP for the United States was $20.49 trillion. Additionally, the United States is ranked second in the world for the approximate value of natural resources and in 2016; the U.S. had an estimated natural resource value of $45 trillion (World Population Review, 2021).

The US is a powerful economy due to several factors. One major reason is that the U.S dollar is the most widely used currency for global transactions. The U.S. is globally known for encouraging entrepreneurship, which breeds innovation and, in turn, leads to economic growth. The growing population in the U.S. has helped diversify the workforce. The U.S. is also one of the leading manufacturing industries in the world, coming only second to China (World Bank Report, 2021).

2.6   Nigeria's Demography and Economic Growth
Nigeria is the most populous country in Africa with approximately 211 million people residing in an area of 923, 768km$^{2..}$ Nigeria is the seventh most populated country of the world (World Fact book, 2018). Most of the population in Nigeria is young. Records show that 42.54% of the Nigerian

Population fall between the ages of 0 – 14 years (World Factbook, 2018; Lysonski *et al.,* 2013; Tartiyus et al., 2015). Nigeria also has a very high dependency ratio of 88.2 dependants per 100 non dependants (World Fact book, 2018).

In the last five decades, the Nigerian population has been increasing due to very high birth rates quadrupling its population during this time. Population growth in Nigeria was fastest in the 1980s, after child mortality dropped rapidly, and has slowed slightly since then as the birth rate has declined slightly. Today, birth rate is 35.2 births per 1000 population with a total fertility rate of about 4.85 children per woman (World Fact book, 2018; Ogunleye and Owolabi, 2018).

According to the 2017 revision of the World Population Prospects, the total population in Nigeria was 185,989,640 in 2016, compared to only 37,860,000 in 1950. The proportion of children under the age of 15 in 2010 was 44.0%, 53.2% were between 15 and 65 years of age, while 2.7% were 65 years or older (World Population Prospects, 2019). However current age structure in Nigeria shows that 42.54% of the population are between ages 0-14, individuals between 15 – 24 years are about 19.81%, those between 25 -54 years are 30.44% while older people between 55 – 65 years and above are about 7 % of the total population (Stonawski *et al.,* 2016; Okeke *et al*., 2017).

Nigeria is a middle income, mixed economy. It is an emerging market with expanding financial, communications, entertainment, financial, service and technology sectors (Review of the Nigerian Economy, 2020; USAID Report, 2017). Nigeria is ranked the 27th largest economy in the world in terms of nominal GDP and it's the 24th largest in terms of purchasing power parity (World Bank, 2020). In Africa, Nigeria has the largest economy. "The country's re-emergent manufacturing sector became the largest on the continent in 2013, and it produces a large proportion of goods and services for the region of West Africa" (Manufacturing Sector Report, 2015).

3.0 Methodology
3.1 Data and method of data collection
This study employed the use of secondary data obtained from World Developments Indicator Data (2019) for China, India, United States and Nigeria. Annual time series data covering the period 1991 to 2020 were obtained and utilized for each country specifically so as to compare results. Our regressand is the growth rate of real gross domestic product (GDPgr), while the regressors are the demographic variables namely; change in share of working age over 5 years (ΔWASgr_ 5Y) and log of initial working age share (logWAS). Other control variables are service sector employment (Serempl), industrial sector employment (Indempl), agricultural sector employment (Agricempl), Life expectancy (Lexp), Capital Investment (Gcf), Secondary school enrolment (Schrol), total population growth (Popgr) and Trade openness (Tradeop).

Preliminary tests using unit root test (Augmented Dickey Fuller Test) was carried out on the specified variables to ascertain the distribution and stationarity of the variables respectively. Our model was estimated using the Auto-regressive Distributed Lag (ARDL) model.

3.2 Model Specification
We followed the theoretical foundation of the neoclassical growth model. This model was adapted to analyze the effects of population growth of working age population on economic growth . It is specified as Equation 1:

$$GDPgr_t = \beta_0 + \beta_1 \log WAS_t + \beta_2 \Delta WASgr\_5Y_t + \beta_3 Agricempl_t + \beta_4 Indempl_t$$
$$+ \beta_5 Serempl_t + \beta_6 Gcf_t + \beta_7 \text{Tradeop}_t + \beta_8 \text{Lexp}_t + \beta_9 \text{Schrol}_t + \varepsilon_t \tag{1}$$

Where:

$GDPgr$	=	growth rate of real GDP (annual %)
$\log WAS$	=	Log of % share of working age in total population (initial working age share)
$\Delta WASgr\_5Y$	=	5 yearly growth of share of working age (%)
$Agricempl$	=	Agricultural sector employment (% of total employment)
$Indempl$	=	Industrial sector employment (% of total employment)
$Serempl$	=	Service sector employment (% of total employment)
Gcf	=	Gross capital formation as a proxy for investment (% of GDP)
Tradeop	=	Trade openness (ratio of trade over GDP)
Popgr	=	Total population growth rate
Lexp	=	Life expectancy,
Schrol	=	Secondary school enrolment in years

While the coefficients of the independent variables are denoted by $\beta_1 \to \beta_{10}$, β_0 is the constant or intercept of the model and t as well as ε are respectively used for the time series dimension of residual terms.

Given the slow dynamic nature of demographic data, we use 5 yearly data for the share of working age over the period 1991 to 2020 (ΔWASGR_5Y). To explain the growth rate of real GDP, we included the growth of working age share (ΔWASGR_5Y), the log of working age share (Log (WAS) which is same as Log of initial working age share, sectoral employment in the agricultural sector (AGRICEMP), industrial sector (INDEMP) and the service sector (SEREMP), trade openness, life expectancy, capital investment, total population growth rate and school enrolment to capture for human capital.

We then depart from Bloom *et al.,* (2010) in four ways. First, our dependent variable is growth rate of real GDP instead of per capita real GDP as used by Bloom *et al.,* (2010). We believe that growth rate of real GDP will better capture the relationship between economic growth and the growth of working age share. Secondly, we do not include institutional quality (bureaucratic quality) as this will unnecessarily curtail the sample size. Thirdly, we replace ΔWAS as in Bloom et al., (2010) with ΔWASGR_5Y. and fourthly we include sectorial employment for agriculture, industry and service sectors and *t* is the period index.

4.0   Results and Discussion
4.1 Pre-estimation Analysis
Summary results of descriptive statistics on Table 1 reveals that average real GDP growth rate (GDPGR) for China, India, United States and Nigeria is 9.29 %, 5.81%, 2.29 % and 4.09% respectively. Average population growth rate stands at 0.70, 5.81, 0.93 and 2.58 for China, India, United States and Nigeria respectively. China has the highest percentage mean working age share of 70.32% while Nigeria has the lowest percentage mean working age share at 53.18%. Average growth rate of working age share was highest in China with a record of 1.13% and lowest in

Nigeria with a record of – 3.80%. In terms of human welfare average life expectancy was highest in the United States at 77.45 years and lowest in Nigeria at 49.27 years. Percentage gross of secondary school enrolment was highest in the United States with 105.21 % and lowest in Nigeria with a record of 35.02%.

Table 1: Summary results of descriptive Statistics

CHINA

	GDP GR	AGSE MPL	ΔWAS GR_5 Y	GCF	INDSE MPL	LEXP	POPG R	SCHR OL	SSEM PL	TRAD EOP	WAS
Mean	9.29	43.12	1.13	40.80	25.43	73.08	0.70	75.45	32.62	42.78	70.32
Median	9.25	45.85	1.58	41.16	24.50	73.12	0.57	68.59	31.80	38.97	70.96
Maximum	14.23	59.70	5.39	46.66	30.30	77.12	1.36	115.39	48.89	64.48	73.26
Minimum	2.30	25.33	-3.20	33.57	21.40	69.24	0.31	38.98	18.90	25.95	65.75
Std. Dev.	2.65	10.90	2.71	4.06	3.10	2.559	0.29	23.30	8.32	10.48	2.63

Source; Author's computation, 2022

INDIA

	GDPG R	AGSE MPL	ΔWAS GR_5Y	GCF	INDSE MPL	LEXP	POPG R	SCHR OL	SSEM PL	TRAD EOP	WAS
Mean	5.81	54.03	3.79	31.78	19.78	64.63	5.81	57.30	26.19	1.53	62.71
Median	6.60	55.54	2.64	30.42	19.11	64.71	6.60	54.43	25.36	1.56	62.67
Maximum	8.85	63.32	10.16	41.93	25.29	69.90	8.85	75.48	32.84	2.04	67.27
Minimum	-7.25	41.87	1.99	23.97	15.18	58.35	-7.25	43.04	21.50	0.99	58.37
Std. Dev.	3.12	7.25	2.91	5.47	3.88	3.58	3.12	12.11	3.42	0.34	2.84

Source; Author's computation, 2022

USA

	GDPGR	AGSE MPL	ΔWA SGR _5Y	GCF	INDSE MPL	LEXP	POPG R	SCHR OL	SSEM PL	TRAD EOP	WAS
Mean	2.29	1.54	-0.56	21.30	22.36	77.45	0.93	105.21	76.11	0.93	66.04
Median	2.62	1.45	-0.51	21.22	22.31	77.59	0.93	96.80	76.30	0.93	66.05
Maximum	4.75	1.93	1.27	23.68	25.96	78.94	1.39	172.23	78.94	1.39	66.88
Minimum	-3.64	1.29	-2.90	17.80	19.64	75.37	0.35	84.03	72.11	0.35	64.99
Std. Dev.	1.90	0.21	1.50	1.43	2.41	1.22	0.26	22.25	2.60	0.26	0.61

Source; Author's computation, 2022

NIGERIA

	GDP GR	AGSE MPL	ΔWAS GR_5 Y	GCF	INDSE MPL	LEXP	POPG R	SCHR OL	SSEM PL	TRAD EOP	WAS
Mean	4.09	43.85	-3.80	27.90	11.99	49.27	2.58	35.02	44.16	37.09	53.18
Median	4.43	44.65	-0.08	27.35	12.01	48.53	2.56	34.71	44.08	37.62	53.24
Maximum	15.33	50.57	1.3	48.40	13.42	55.04	2.68	56.21	53.60	53.28	53.77
Minimum	-2.04	34.41	-24.44	14.90	10.15	45.84	2.49	23.55	36.01	20.72	52.17
Std. Dev.	3.91	5.62	9.42	10.43	0.93	3.27	0.07	10.59	6.17	8.75	0.39

Source; Author's computation, 2022

4.2   *Stationarity test result*
The result of the unit root analysis using Augmented Dickey Fuller (ADF) test for the four countries (Tables 2, 3, 4, and 5) reveals that the variables exhibit mixed order of integration in the four countries. While some of the variables have a unit root at I (0), others were at I (1). That is, a short-run equilibrium exists between the variables. Based on this result, we employed ARDL model, the most suitable cointegration technique in this case to establish whether there is a long-run relationship among the specified variables.

Table 2: Unit Root Analysis using Augmented Dickey Fuller Test

Variables	CHINA				Remarks
	Levels		First Difference		
	Constant & Trend		Constant & Trend		
	T-Statistics	Probability	T-Statistics	Probability	
log GDPgr	-5.05	0.97	-2.45	0.02**	I (1)
log *WAS*	-6.37	0.00***	-3.04	0.14	I (0)
$\Delta WASgr\_5Y$	-1.70	0.73	-5.39	0.00***	I (1)
Agricempl	-2.44	0.02**	-2.25	0.44	I (0)
Indempl	-1.90	0.07*	-1.94	0.05**	I (1)
Serempl	-0.57	0.99	-2.95	0.05**	I (1)
Gcf	-2.54	0.31	-3.79	0.03**	I(1)
Tradeop	-0.98	0.93	-3.89	0.03***	I (1)
Lexp	-6.16	0.00***	-4.64	0.00***	I (0)
Schrol	-2.78	0.22	-2.17	0.09*	I (1)
Popgr	-2.19	0.48	-3.63	0.05**	I (1)

Source: Authors' computation, 2022

Table 3: Unit Root Analysis using Augmented Dickey Fuller Test

Variables	NIGERIA				Remarks
	Levels		First Difference		
	Constant & Trend		Constant & Trend		
	T-Statistics	Probability	T-Statistics	Probability	
log GDPgr	-3.41	0.02	-5.81	0.00***	I (1)
log *WAS*	-12.91	0.00***	-3.06	0.14	I (0)
$\Delta WASgr\_5Y$	-2.07	0.54	-5.48	0.00***	I (1)
Agricempl	-1.82	0.06*	-1.67	0.73	I (0)
Indempl	-1.73	0.71	-2.50	0.01***	I (1)
Serempl	-2.68	0.25	-0.61	0.09*	I (1)
Gcf	-1.90	0.06	-4.45	0.00**	I (1)
Tradeop	-3.16	0.11	-6.15	0.00***	I (1)
Lexp	-4.09	0.02**	-5.08	0.00***	I (I)
Schrol	-4.49	0.00***	-4.95	0.00***	I (0)
Popgr	-3.96	0.02**	-1.83	0.66	I (0)

Source: Authors' computation, 2022

Table 4: Unit Root Analysis using Augmented Dickey Fuller Test

| Variables | USA | | | | Remarks |
| | Levels Constant & Trend | | First Difference Constant & Trend | | |
	T-Statistics	Probability	T-Statistics	Probability	
log GDPgr	-4.36	0.00	-6.42	0.00***	I (1)
log *WAS*	-3.74	0.00***	-0.42	0.14	I (0)
Δ*WASgr_5Y*	-1.85	0.65	-5.50	0.00***	I (1)
Agricempl	-2.69	0.01***	-4.34	0.00***	I (0)
Indempl	-1.93	0.61	-3.62	0.05**	I (1)
Serempl	-1.53	0.79	-2.36	0.02**	I (1)
Gcf	-2.92	0.17	-3.77	0.03**	I (1)
Tradeop	-4.24	0.01***	-4.01	0.02**	I (0)
Lexp	-0.92	0.94	-5.01	0.00***	I (I)
Schrol	-1.91	0.62	-7.43	0.00***	I (1)
Popgr	-4.25	0.01***	-4.01	0.02**	I (0)

Source: Authors' computation, 2022

Table 5: Unit Root Analysis using Augmented Dickey Fuller Test

| Variables | INDIA | | | | Remarks |
| | Levels Constant & Trend | | First Difference Constant & Trend | | |
	T-Statistics	Probability	T-Statistics	Probability	
log GDPgr	-3.72	0.04**	-6.64	0.00***	I (1)
log *WAS*	-3.01	0.15	-2.69	0.08*	I (1)
Δ*WASgr_5Y*	-2.30	0.02**	-5.53	0.00***	I (1)
Agricempl	-2.31	0.02**	-2.91	0.18	I (0)
Indempl	-2.23	0.45	-1.62	0.01***	I (1)
Serempl	-0.84	0.95	-3.04	0.10*	I (1)
Gcf	-0.82	0.96	-5.41	0.00***	I (1)
Tradeop	-3.52	0.06*	-1.08	0.91	I (0)
Lexp	-2.21	1.00	-9.53	0.00***	I (I)
Schrol	-2.74	0.23	-5.59	0.00***	I (1)
Popgr	-1.66	0.74	-4.74	0.00***	I (0)

Source: Authors' computation, 2022

4.3 *Cointegration test result*

The result obtained from the ARDL bound test approach to co-integration is presented in Table 6. Our calculated F-value is compared with the values of both the upper and lower bounds and we find existence of long run relationship or co-integration among the variables in our model.[1] Having confirmed the existence of a stable long -run relationship among the specified variables, we went further to established the magnitudes of the short and long run coefficients of the effects of the parameters on output growth (see Table 7and 8).

Table 6: ARDL bounds test result for Nigeria, India, China and USA

Test Statistics	Value Nigeria	Value India	Value China	Value USA		K	Decision
F- Statistics	19.10	25.33	6.76	9.98		10	
Critical Value Bounds					I 0	I 1	
Significance					1.76		
10%					1.98	2.77	Co – integration
5%					2.18	3.04	Co – integration
2.5%					2.41	3.28	Co – integration
1%					1.76	3.61	Co – integration

Source: Authors' computation, 2022

4.4 ARDL Long-run and short-run model results for Nigeria

On Table 7, variables exhibiting positive long-run relationship with economic growth are growth of the share of working age; sectoral employment (for agriculture, industry and service sector); life expectancy, years of secondary education and trade openness. The log of initial share of working age was negative and insignificant.

In the same vein, the short-run estimates for Nigeria as revealed on Table 8 showed a positive relationship between log of initial share of working age; agricultural, industrial and service sector employments; life expectancy, years of secondary school enrolment, trade openness and economic growth. On the other hand, gross capital formation and the overall population growth presented a negative relationship with economic growth. The speed of adjustment to long- run equilibrium was negative and highly significant as expected. These results indicate that, an increase in total population has a detrimental effect on economic growth in Nigeria both in the short and long-run. We also found that growth in the share of working age will boost economic growth in the long-run and an increase in the initial share working age will also boost economic growth in the short-run.

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[1] See Pesaran, et al., 2001; Narayan and Smyth, 2005 and Mesagan, et al., 2019 among others for the criteria for decision making regarding the existing or otherwise of long run contegation from an ARDL bound test.

Table 7: Long run results for Nigeria

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4346.306	1515.482	-2.867936	0.0209
AGSEMPL	43.7224**	15.33405	2.851330	0.0214
DWASGR_5Y	0.02447**	0.008807	2.777834	0.0240
GCF	-0.1273***	0.034534	-3.685360	0.0062
INDSEMPL	42.3300**	14.91591	2.837910	0.0219
LEXP	1.8527***	0.533197	3.474735	0.0084
LOGWAS	-1.301783	51.93504	-0.025066	0.9806
POPGR	-10.7820*	5.431565	-1.985061	0.0824
SCHROL	0.1444***	0.033946	4.253446	0.0028
SSEMPL	41.995**	15.03358	2.793417	0.0234
TRADEOP	0.0352***	0.009021	3.899143	0.0046
R-squared	0.983345		Mean dependent var	0.015369
Adjusted R-squared	0.975456		S.D. dependent var	0.395125
S.E. of regression	0.061902		Akaike info criterion	-2.45974
Sum squared resid	0.072805		Schwarz criterion	-1.98826
Log likelihood	45.66620		Hannan-Quinn criter.	-2.31208
Durbin-Watson stat	2.765114			

Source; Author's computations
*, ** and*** represents 10%, 5% and 1% level of significance

Table 8: ECM Regression for Nigeria

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGSEMPL)	21.67757	1.891771	11.45887	0.0000
D(GCF)	-0.046404	0.004857	-9.554310	0.0000
D(INDSEMPL)	20.61068	1.876534	10.98337	0.0000
D(LEXP)	12.71403	0.607825	20.91727	0.0000
D(LOGWAS)	371.3981	27.33465	13.58708	0.0000
D(POPGR)	-70.71899	2.841679	-24.88634	0.0000
D(SCHROL)	0.072471	0.004076	17.77890	0.0000
D(SSEMPL)	20.61825	1.877724	10.98045	0.0000
D(TRADEOP)	0.014801	0.001643	9.010996	0.0000
CointEq(-1)	-1.705235	0.073084	-23.33242	0.0000

Source; Author's computations
*, ** and*** represents 10%, 5% and 1% level of significance

4.5 ARDL Long -run and short-run model results for India

The ARDL long-run estimates for India shows that total population growth has an inverse relationship with economic growth. The change in share of working age and the log of the initial share of working age was positive though insignificant in the long-run. Other variables exhibiting positive long-run relationship with economic growth was sectoral employment (for agriculture, industry and service sectors) significant at 1% each.

Table 9: Long run form for India

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1013.003	287.1194	-3.528159	0.0078
AGSEMPL	10.0359***	2.838941	3.535072	0.0077
DWASGR_5Y	0.0057	0.008369	-0.675121	0.5186
GCF	0.0065	0.006412	1.014927	0.3398
INDSEMPL	10.0429***	2.844723	3.530364	0.0077
LEXP	-0.1744	0.123642	-1.410868	0.1960
LOGWAS	13.7591	26.20221	0.525113	0.6137
POPGR	-0.0295**	0.012963	-2.274323	0.0524
SCHROL	0.0087	0.005343	1.622769	0.1433
SSEMPL	9.9522***	2.811590	3.539716	0.0076
TRADEOP	-1.1809	1.264994	-0.933502	0.3779
R-squared	0.997737		Mean dependent var	-0.000828
Adjusted R-squared	0.996665		S.D. dependent var	0.247672
S.E. of regression	0.014304		Akaike info criterion	-5.389769
Sum squared resid	0.003887		Schwarz criterion	-4.918288
Log likelihood	88.15166		Hannan-Quinn criter.	-5.242107
Durbin-Watson stat	3.086892			

Source; Author's computations
*, ** and*** represents 10%, 5% and 1% level of significance

The error correction model results (Table 10) for India revealed that the growth of share of working age and initial working age share had positive relationship with economic growth in the short-run. Sectorial employment (for service, agriculture and industrial sectors) and gross capital formation also had positive relationship with economic growth of India at 1 percent level of significance each. The speed of adjustment was negative and significant at 1 percent. Based on these results, we inferred that population growth of India has a negative relationship with economic growth. We also inferred that an increase in share of working age will boost economic growth of India.

Table 10: ECM Regression for India

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGSEMPL)	4.6885***	0.505873	9.268143	0.0000
D(DWASGR_5Y)	0.0204***	0.002278	8.960812	0.0000
D(GCF)	0.0113***	0.001477	7.638895	0.0001
D(INDSEMPL)	4.7088***	0.508470	9.260669	0.0000
D(LEXP)	-1.5294***	0.079142	-19.32417	0.0000
D(LOGWAS)	73.121***	8.888995	8.226123	0.0000
D(POPGR)	-0.0555***	0.001159	-47.85916	0.0000
D(SCHROL)	0.00089	0.001880	0.477959	0.6455
D(SSEMPL)	4.5889***	0.505646	9.075232	0.0000
CointEq(-1)	-0.8134***	0.030273	-26.86759	0.0000

Source; Author's computations
*, ** and*** represents 10%, 5% and 1% level of significance

4.6 ARDL Long-run and short-run model results for China
The ARDL long-run results from Table 11 revealed that total population growth has an inverse relationship with economic growth of China. The initial working age share was significant and positively related to economic growth in the long run. Life expectancy is inversely related to

China's economic growth because her current population is ageing and overblown being one of the most populous countries of the world. Trade openness also contributes to economic growth in the long-run.

Table11: ARDL long run form for China

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-61.27013	18.35929	-3.337283	0.0059
AGSEMPL	-0.028014	0.099089	-0.282717	0.7822
DWASGR_5Y	0.042438	0.038938	-1.089902	0.2972
GCF	-0.006485	0.025482	-0.254497	0.8034
INDSEMPL	0.004127	0.079577	0.051865	0.9595
LEXP(-1)	-0.074132	0.147926	-0.501141	0.6253
LOGWAS	37.9636***	10.28539	3.691021	0.0031
POPGR	-0.411405	0.481703	0.854064	0.4098
SCHROL	-0.039996	0.025334	-1.578721	0.1404
SSEMPL	0.051326	0.051983	0.987362	0.3430
TRADEOP	0.01625*	0.008482	1.915975	0.0795
R-squared	0.889022		Mean dependent var	-0.02086
Adjusted R-squared	0.864896		S.D. dependent var	0.097229
S.E. of regression	0.035738		Akaike info criterion	-3.64321
Sum squared resid	0.029376		Schwarz criterion	-3.36032
Log likelihood	58.82657		Hannan-Quinn criter.	-3.55462

Source; Author's computations
*, ** and*** represents 10%, 5% and 1% level of significance

Results of error correction model for China on Table 12 shows that population growth was inversely related to economic growth being significant at 1%. Variables exhibiting positive significant relationship with economic growth are growth of share of working age and trade openness. However, life expectancy had an inverse relationship with economic growth at 1% level of significance. Based on this result, we can infer that population growth has an inverse relationship with economic growth in China. We also note that increase in the share of working age contributes positively to economic growth in the short-run, while increase in life expectancy hampered economic growth due to the aging population in China.

Table 12: ECM Regression for China

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DWASGR_5Y)	0.0194**	0.007080	2.734355	0.0181
D(LEXP)	-0.8020***	0.077165	-10.39331	0.0000
D(POPGR)	-1.7850***	0.216549	-8.243264	0.0000
D(SCHROL)	-0.0611***	0.006582	-9.285585	0.0000
D(TRADEOP)	0.0044**	0.002028	2.173683	0.0505
CointEq(-1)	-0.1084***	0.008696	-12.46788	0.0000

Source; Author's computations
*, ** and*** represents 10%, 5% and 1% level of significance

4.7 ARDL Long-run and short-run results for USA

Table 13 shows that population growth of USA has a negative significant relationship with economic growth in the long run. The initial working age share also had a positive relationship with economic growth in the long run. On the other hand, improvement in sectoral employments contributes negatively to economic growth in the long run but gross capital formation had a strong positive relationship with economic growth.

Table 13: Long run form for USA

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1443.700	648.2958	2.226915	0.0429
AGSEMPL	-13.5208*	6.503577	-2.078981	0.0565
DWASGR_5Y	0.00246	0.032244	0.076211	0.9403
GCF	0.1098**	0.039261	2.796812	0.0143
INDSEMPL	-13.8286**	6.502685	-2.126599	0.0517
LEXP	-0.1811	0.159103	-1.138266	0.2741
LOGWAS	38.7691*	19.52178	1.985942	0.0670
SSEMPL	-13.5657*	6.524866	-2.079074	0.0565
TRADEOP	1.3307**	0.493876	2.694427	0.0174
POPPGR	-1.2137*	0.654922	-1.853200	0.0757
R-squared	0.926532		Mean dependent var	0.000000
Adjusted R-squared	0.910561		S.D. dependent var	0.23286
S.E. of regression	0.069640		Akaike info criterion	-2.30895
Sum squared resid	0.111545		Schwarz criterion	-2.02606
Log likelihood	39.47979		Hannan-Quinn criter.	-2.22035
Durbin-Watson stat	2.240042			

Source; Author's computations

*, ** and*** represents 10%, 5% and 1% level of significance

Short run results for USA on Table 13 revealed that gross capital formation had significant positive relationship with economic growth. Agricultural, industrial and service sector employment had negative relationship with economic growth. The speed of adjustment to long run equilibrium was 96%, negative and significant at 1% implying its effective use for policy formulation.

Table 14: ECM Regression for USA

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGSEMPL)	-5.341568**	2.163460	-2.468993	0.0270
D(GCF)	0.261753***	0.021990	11.90308	0.0000
D(INDSEMPL)	-5.198110**	2.151754	-2.415755	0.0300
D(LEXP)	0.134789	0.091271	1.476800	0.1619
D(SSEMPL)	-4.810209**	2.169584	-2.217111	0.0437
CointEq(-1)	-0.962201***	0.075132	-12.80682	0.0000

Source; Author's computations

*, ** and*** represents 10%, 5% and 1% level of significance

Based on this result, we infer that an improvement in population growth will decrease economic growth in USA. We also infer that an increase in the working population will aid economic growth in the long run. Gross capital formation contributes positively to economic growth in the US both in the long and short run.

4.8 Residual Diagnostic Statistics

Diagnostic statistics on Table 15 show that the variables are homoscedastic and there is no serial correlation in the error term of the variables. Jaque Bera statistics showed normality in the data and Cusum sum of squares test shows stability in the data.

Table 15: Results of Residual Diagnostic Tests

Country	Diagnostic test	F statistics	Probability
	Breusch-Godfrey serial correlation test		
Nigeria		2.42	0.170
India		25.21	0.001
China		1.42	0.271
USA		1.43	0.130
	Heteroskedasticity test		
Nigeria		0.81	0.672
India		0.87	0.625
China		1.42	0.271
USA		3.19	0.019
	Jaque Bera Statistics		
Nigeria		1.99	0.368
India		0.91	0.635
China		0.003	0.998
USA		0.178	0.915
	Cusum Sum of squares test		
Nigeria		Stable	
India		Stable	
China		Stable	
USA		Stable	

Source; Author's computations
*, ** and*** represents 10%, 5% and 1% level of significance

5.0   Conclusion and Recommendations

The main drift of this study is to examine the relationships between population dynamics and economic growth (proxy by real GDP growth rate) in four most populous countries of the world namely: China, India, United States of America and Nigeria. The findings of the study support short-run and long-run relationships between population and economic growth. It revealed that total population growth had negative effect on economic growth in all the four countries. However, in Nigeria, change in working age population, sectoral employment and trade openness had significant positive effects on economic growth both in the long-run and short-run. In India, change in working age population has no effect on economic growth in the long-run but showed significant positive effects in the short-run. Similarly, in China and United States, change in working age share had no effect on economic growth in the long-run though in both countries, initial working age share revealed positive long run effects on the economic growth. This might be due to China's ageing population and the low fertility rate in the U.S. Furthermore, Gross capital formation was found to have strong positive effect on economic growth in the US. The study recommends better policies that would improve the share of working age population in the countries in order to improve economic growth. A young population of people in a country will benefit more from contributions from the working class to improve economic growth if properly empowered.

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