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On the Economic Growth Effect of Population: Evidence from World Most and Least Populous Countries

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Abstract: This study assesses the importance of population growth in economic growth in the six most populous and six least populous countries in the world for data spanning 1985 to 2022. Results from the panel autoregressive distributed lag indicate that population has no significant effect on economic growth in the short run in any of the country groups but it shows positive relationship. Population enhances economic growth more in the most populous countries than in the least populous countries in the long run. In addition, population is persistent in impacting economic growth of the most populous countries. Decrease in unemployment rate enhances economic growth rate more in the least populous countries than in the most populous countries. Human capital development is also important for economic growth and more pronounced in the least populous countries. Following these results, it is concluded that population matters importantly for economic growth and that the most populous country is more likely to experience higher economic growth than the least populous country. The study recommends that that a carefully planned population growth strategy will be beneficial to both country groups. In the most populous countries, plans that will allow for more inflow of peoples should be looked forward into because most of these countries are embarking on birth control in order to reduce population. It is also recommended that the least populous countries should ensure that a considerable size of the population translates to human capital.

Keywords: Economic activity; demography; Panel ARDL; human capital; country group

JEL Classification: E7; J110; C340

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1. Introduction

The impact of population growth on economic growth is one of topical issues in development studies as it tries to examine if population growth enhances economic growth or not. As the twenty-first century begins, the world's population was estimated to be almost 6.1 billion and it was projected that by 2050, population will be more than 9.2 billion before reaching a pick of 11 billion by 20200 with 90% to be inhabited the developing world (Todaro & Smith, 2006). At about 200 centuries, population growth and economic growth were positively related, that is, more population meant more technological discoveries, greater economic expansion, and hence increased economic growth. In fact, the current modernization and technological advancement is highly attributable to centuries of rapid population growth.

There are three schools of taught in population-economic growth nexus, namely the population pessimists, the population optimists and the population neutralists. The population optimists led by Boserup (1981) claimed that growing population will impact positively on the economy because it will make room for economies of scale as well as promotion of technological and institutional innovations. According to this view, population are desirable and not a problem. Higher population growth means higher labour supply that leads to economic growth.

The population pessimists are the followers of the Malthusian school of thought which holds that population growth is a problem for economic growth and overall welfare. According to this thought, insofar a country seeks to attain a specific growth, increase in population will bring stand on the way and may even bring the economy to a standstill if urgent steps are not taken. This is because more population means more mouth to be fed. Ot turns out that as population is growing at a faster rate than food supply, this disequilibrium will adversely affect the economy. This point was supported by scholars like Coale and Hoover (1958) who claim that rapid population growth will strangulate economic activity since it will overwhelm any induced response by technological progress and capital accumulation. In fact, the modern demographic version of the pessimists embraces a "*doomsday scenario"* that assumes that population growth poses a grave consequence on human wellbeing and its natural environment (Zhizhi & Owuda, 2019).

The population neutralists opine that population growth has no influence on economic growth (Bloom & Freeman, 2000; Sachs & Warner, 1995). According to this thought, the perceived negative correlation between population growth and economic growth becomes unobservable once other variables like country size, openness to trade, and level of education attainment among others are excluded in the model. Thus, from the theoretical point, there is no unanimous agreement on the impact of population on economic growth.

From the empirical point of view, the evidences are diverse. On the one hand, population enhances economic growth (Yao & Tomoko, 2013; Huang & Xie, 2013; Klasen & Lawson, 2007; Jan, Hullah & Ahmed, 2021; Alemayehu & Berhanu, 2022). On the other hand, population growth is inimical to economic growth (Li & Zhang, 2007; Bloom & Freeman, 2000; Savas, 2008; Afzal, 2009). Further, some studies found no relationship between population growth and economic growth such as, Liddle (2003).

In developed and emerging economies, population is well managed because they utilize the available labour force. China for instance, utilizes its labour force productively and the result leads to growth breakthrough. In fact, when China tried to reduce population growth, output growth also fell. Specifically, China's population growth was reduced from 0.47 percent in 2018 to 0.43 percent in 2019 and its economic growth fell from 6.6 percent in 2018 to 6.2 percent in 2019. On the other hand, population growth of Sao Tome and Principe which is the least populous country in Africa was 0.35 percent in 2018 but fell slightly to 0.34 percent in 2019 and its growth rate rose from 3.9 percent to 4.1 percent in the same period. In 2018, Nigeria's economy grew at the rate of 1.5 percent and increased to 1.9 percent in 2019 but its population growth actually fell from 2.62 percent to 2.60 percent in the same period. This suggests that depending on the country, population growth may contribute, deter or have no impact on economic growth.

There are large and growing empirical works on the population-growth nexus. The most recent include Akintunde *et al* (2013), Chang *et al* (2014), Aidi et al (2017), Zhizhi and Owuda (2019) and Alamayehu and Berhamu (2022). However, these studies, and a host of others do carry out a comparative analysis in the context of most populous and least populous countries in the world. The implication of this is that the received evidence does not allow for a succinct declaration on whether most populous countries grow faster than least populous countries. In other words, does population influences economic growth more in the most populous countries than least populous countries? A deeper analysis is needed in this regard so as to see clearly if the most populous countries grow fast because of their large population or the least populous countries grow fast because of their small population. If population is good for economic growth, it is expected that the most populated countries should experience positive and faster economic growth than least populous countries.

Another way of looking at the same issue is to ask if the least populous countries will grow fast if they are able to increase rate of demographic expansion. To address this issue, twelve countries, comprising six most populous and six least populous countries in the world are selected. The six most populous countries are Australia, Brazil, China, Nigeria, Russia and USA and the six least populous countries are French Polynesia, Iceland, Maldives, Sao Tome and Principe, Saint Vincent and

Suriname. After the introductory section, sections two and three discus the review of empirical evidence and the methodology respectively while sections four and five presents, analyses the results and concludes the study respectively.

2. Literature Review

The various theories utilized to investigate the nexus between population and economic growth are the demographic transition theory, the Malthusian growth theory and the modern theory of population. Demographic transition theory refers to a population cycle that begins with a fall in death rate, continues with a phase of rapid population growth and concludes with a decline in birth rate. This theory shows that for an economy to have developed, it must have passed through the stages of population growth. Thus, the different stages of population show a relationship between population and economic growth. The Malthusian growth theory focuses on the relationship between output growth, in this case, food production and population growth. According to the theory, output growth increases arithmetically while population grows geometrically and it is needed to check the growth of population. This checks as postulated by Malthus is called moral restraint.

The modern theory also known as optimum population is regarded as the state of equilibrium between the population and the resources, which satisfies the well-defined needs of the community but varies in both time and space. This theory shows the relationship between income per capita growth and the size of population. The optimum population shows that the available resources is ideal to cater for the size of population. However, the optimum population is likely to change as a result of level of technology and productivity.

These theories have been subjected to empirical investigation in one way or the other. Expectedly, findings are mixed, and inconclusive. However, due to scarcity of space, only the very recent papers are reviewed. Thuku *et al* (2013) analyzed the impacts of population on economic growth in Kenya utiliziing data from 1963 to 2009, in the context of vector autoregressive distributed lag (ARDL) method. The result suggests that the influence of population on economic development is positive and significant both in the long and short runs. Tsangyao et al (2014) examine the case of 21 countries in the context of Bootstrap panel Granger causality for data spanning 1870-2013. Result indicates that there is a one-way causality running from population growth to economic growth for Finland, France, Portugal and Sweden and a one-way causality running from economic growth to population growth for Canada, Germany, Japan, Norway, Switzerland. However, no causal relationship between population growth and economic growth in Belgium, Brazil, Denmark, Netherlands, New Zealand, Spain, Sri Lanka, UK, USA and Uruguay.

Gideon *et a*l (2015) apply vector autoregressive model to analyze the impact of population change on economic growth in Kenya for the period 1963-2009. Their findings reveal that increase in population leads to increased economic growth. Also, in line with the study of Gideon *et al* (2015) but with different coverage area, that is, Nigeria is the work of Eli *et al* (2015).. Data for the period 1980-2010 were estimated by utilizing ordinary least square method (OLS). The authors discovered a positive effect of population growth on economic growth. Still in Nigeria, Tartiyus et al (2015) examine the same issue with the same sample period, that is, 1980-2010. The authors also adopt OLS and find positive and significant effect of population growth on economic growth. The study of Ogunleye *et al* (2018) for Nigeria observe that population growth positively and significantly influences economic growth, adopting OLS method for data spanning 1981 to 2015. In the same vein, Zhizhi and Owuda (2019) carry out qualitative study on the population-growth relationship in Nigeria and suggests that population should positively influence economic growth if environmental degradation can be put under control.

However, in the study of Hakeem *et al* (2017), there is no causal relationship between economic growth and population in Nigeria. This was revealed when data spanning 1970 to 2013 were subjected to Granger causality test. Onwuka (2006) pursued the same study further, utilizing data between 1980 and 2003. Result from the OLS method suggest that population growth actually drags economic growth in Nigeria. Also, a study by Hakeem et al (2017) on the same subject matter for Nigeria for the period 1970-2014 finds, in their OLS method that fertility rate and net migration (proxy for population growth) is inimical to economic growth.

Shah *et a*l (2015) examined the relationship between economic growth and population growth in Bangladesh using data spanning 1980 to 2005. The result from the OLS indicates that economic growth and population are both negatively correlated and that an increase in population will have a negative impact on the economic growth of Bangladesh. Garza-Rodriguez *et al* (2018) examined the case of Mexico. The study covered 1960-2014. The result of the vector error correction model (VECM) indicates that in the short run, population has negative effect on economic growth while in the long run, population growth positively effects economic growth. Meanwhile, result from the Granger causality test suggests the existence of bi-directional causality between population growth and economic growth in Mexico.

Examining the effect of population on economic growth in Pakistan, Ahmad and Ahmad (2016) found in their ARDL result for the period 1981 to 2010 that population growth had a positive impact on economic growth. Similarly, Jan *et al* (2021) utilized data from 1961 to 2020 to assess the impact of population growth on economic growth in Pakistan. The result of the ARDL indicates that population growth is an enhancing mechanism for economic growth. Also, Alemayehu and

Berhanu (2022) found positive effect of population growth on economic growth in Ethiopia for data spanning 1980 to 2020 in the context of ARDL method.

From the brief empirical evidence presented, studies only convers a few most populated countries, that is, Nigeria, Bangladesh and no readily available evidence in the case of the least populous countries. It is also of interest that evidence on population-growth nexus for a country like China and the US is elusive in the recent time. Another observation from the review is that the method of estimation for most of the studies was ordinary least square (OLS) while very few employed ARDL (Auto Regressive Distributed Lag). This study expands the numbers of most populous countries in the assessment of the effect of population on economic growth. The study also employs ARDL for a panel of six most and least populous countries respectively. This is a departure from country-based analysis mostly found in the extant literature.

3. Method and Data

Theories that relate population growth to economic growth suggests that there could be positive, negative or no effect. The. Demographic Transition Theory opines that the stage in population that a country is determines its economic growth. The Malthusian growth theory submits that increasing rate of population is inimical to economic growth while the optimum population theory argue that population may or may not enhance economic growth depending on whether the optimum population has been reached or not on the one hand, and the level and nature of initial technology. If the initial technology is easily accessible and can create further new technology for production then population growth rate will unambiguously facilitate economic growth. However, if the initial technology is difficult to access or is wrongly implemented, it may cause unemployment and this could cause a drag to economic growth. Thus, there is no clear-cut direction of effect of population growth on economic growth. However, following these theories, the relationship between population and economic growth can be summarized in equation 1

$$Y_t = f(P_t, X) \tag{1}$$

where Y_t is the GDP growth rate defined as the percentage change in GDP, while P_t is the population growth rate and X is other catchall variables that affects economic growth such as expenditure on human capital, physical capital and unemployment.

The method of estimation employed is the panel autoregressive distributed lag (P-ARDL) developed by Pesaran and Shin (1999) and re-assessed by Pesaran *et a*l (2001). The approach provides several advantages in evaluation of co-integration and short and long run linkages. Among the several advantages is that, unlike traditional co-integration methods of Johansen's tests (Johansen, 1991), Granger

causality test and the Vector Autoregressive (VAR) model, ARDL can be utilized to estimate models where the series exhibits I(0) or I(1), that is, stationary at level or stationary at first difference) as well as for a mix of I(0) and I(1) (Duasa, 2007). Another advantage is that, by integrating the short run impact of the given variables with a long run equilibrium using error correction term, it allows for the assessment of both the short and long run relationship between the given variables simultaneously. Thus, in order to capture the short run and long run effect of population growth on economic growth, the panel ARDL model is specified in equation 2

$$\Delta GDPGR_{ct} = \alpha_0 + \delta_{1i} GDPGR_{ct-1} + \delta_{2i} POPGR_{ct-1} + \delta_{31} HEXP_{ct-1} + \delta_{4i} UNEMP_{ct-1} + \delta_{5i} GCF_{ct-1} + \sum_{i=1}^{m1} \pi_{it} \Delta GDPGR_{cit-i} + \sum_{i=0}^{m2} \sigma_{it} \Delta POPGR_{cit-i} + \sum_{i=0}^{m3} \varphi_{it} \Delta HEXP_{cit-i} + \sum_{i=0}^{m4} \lambda_{it} \Delta UNEMP_{cit-i} + \sum_{i=0}^{m4} \lambda_{it} \Delta GCF_{cit-1} + \varepsilon_{it} \quad (2)$$

where GDPGR is economic growth, POPGR is population growth, HEXP is health expenditure, GCF is gross capital formation, UNEMP is unemployment rate, *c* is country, *i= i,…,n* is number of lags, *t=i,…,t* is the time index and ε_{it} is the random disturbance term.

Unit roots and cointegration tests are performed in order to ensure that the series are valid for estimation in the panel ARDL setting. The unit root test is used to examine the stationarity of the series in which the mean and variance must be constant over time and the value of covariance between two periods must depend only on the lag between the two periods. A variable is said to be stationary if its mean, variance and auto covariance remains constant overtime. In panel data, there are two major unit root tests, namely, the common root and the individual root. For this study, Levin-Lin-Chu common root and Im-Pesaran-Shin individual root are employed. It is important to test if there exists long run convergence of the model to equilibrium after a distortion. Cointegration test is employed to do this.

This study employs data that spans 1985-2022. Data for all the variables and countries are sourced from the World Development Indicators (WDI) published by the World Bank. The six most populous countries employed for this study are Australia, Brazil, China, Nigeria, Russia and USA while the six least populous countries are French Polynesia, Iceland, Maldives, Saint Vincent, Sao Tome and Principe and Suriname. The definition and measurement of variables is summarized in Table 1

Table 1. Summary of Definition and Measurement of Variables

Variables	Definition	Measurement
POPGR	It is the total number of all residents of a country regardless of legal status or citizenship.	Log of difference of population between two years multiplied by 100
GCF	It is the annual growth of gross capital formation based on local currency.	Log of difference of gross capital formation between two years multiplied by 100
UNEMP	people who are available physically and mentally for work but unable to be absorbed	Share of unemployed labour in total labour force
PHEXP	Health expenditure, in constant local currency unit	This is measured as the share of health expenditure in total government expenditure, in real term
GDPGR	It is the annual growth of gross domestic product in constant (2015) term	Log of difference of real GDP between two years multiplied by 100

Source: Author's Compilation.

4. Presentation of Results and Discussions

Table 2 presents the statistical properties of the variables for the both the most populous countries and least populous countries. The average growth rates of GDP, gross capital formation and population between 1985 and 2022 in the case of most populous countries was 4.5%, 7.2% and 1.1% respectively. Similarly, the average share of public health expenditure in same country group is 7.58%. The highest and lowest GDP growth rate were 15.3% and -7.8% respectively. The growth rate of gross capital formation reached its peak with a value of 75.2% and its lowest with a value of -41.0%. Public health expenditure's share in total government spending had the maximum share of 17.1% and minimum value of 2.1 %. Population growth rate recorded maximum of 2.3% and minimum of -0.5%. The maximum value for unemployment rate was 11.6% and the minimum value was 3.3% during the sample period. Population growth rate has the lowest dispersion with the value of 0.87 followed by unemployment rate (1.93) followed by GDP growth (3.8), health expenditure (4.1) while gross capital formation has the highest dispersion (15.14).

The fact that the values for skewness statistics are greater than zero suggests that all the series are positively skewed. The kurtosis value whose threshold is 3 indicates that gross capital formation and GDP growth rates are leptokurtic since their respective kurtosis values are greater than 3 while public health expenditure, population growth and unemployment rates are platykurtic with values less than 2. Although skewness and kurtosis are to determine the normal distribution of the series, they are not individually sufficient in defining the distribution of the series.

An alternative to this is the Jarque-Bera statistics which combines skewness and kurtosis properties and provides a more comprehensive report. The null hypothesis for the Jarque-Bera is that the distribution is normal. Following this null hypothesis, GDP and population growth rates are normally distributed while gross capital formation, unemployment rate and public health expenditure are not (Table 2). The implication of this is that the usual application of ordinary lest square cannot be utilized for estimating equation and this is one of the reasons why a more improved method such as ARDL is employed.

Table 2. Statistical Properties of the Series

country group	**Most Populous countries**					**Least Populous countries**			
Statistics	**GDP GR**	**GCF**	**PHE XP**	**POP GR**	**UNE MP**	**GDP GR**	**PHE XP**	**POP GR**	**UNE MP**
Mean	4.56	7.16	7.58	1.07	5.97	3.81	6.93	1.57	10.11
Maximum	15.33	75.20	17.07	2.68	11.59	26.11	12.36	4.57	21.13
Minimum	-7.79	-41.00	2.143	-0.46	3.30	-13.13	0.74	-0.14	1.87
Std. Dev.	3.78	15.14	4.12	0.87	1.93	4.83	2.41	1.22	6.55
Skewness	0.03	1.14	0.94	0.46	0.81	0.35	-0.15	0.64	0.37
Kurtosis	3.85	8.21	2.76	2.57	2.76	8.88	2.44	2.89	1.66
Jarque-Bera	3.09	137.44	15.12	4.43	11.34	122.67	1.38	5.81	8.23
(Prob)	(0.21)	(0.00)	(0.00)	(0.11)	(0.00)	(0.00)	(0.50)	(0.06)	(0.02)
Observations	222	222	222	222	222	222	150	222	143

***Note**: GDPGR is growth rate of GDP; GCP is the growth rate of gross capital formation; PHEXP is the share of public health expenditure in GDP, POPGR is the growth rate of population and UNEMP is unemployment rate. Data of GCF is not available for the least developed countries.*
Source: Compiled by the Author

In the case of least populous countries, the average value of GDP growth rate, public health expenditure, population growth and unemployment rates are 3.81%, 6.9%, 1.66% and 10.11% respectively (Table 2). The highest and lowest GDP growth rate were 26.11% and -13.13% respectively, public health expenditure has a maximum value of 12.36% and minimum value of 0.74%, and the corresponding maximum and minimum values of population growth rate was 4.57% and -0.14%. The maximum value for unemployment rate was 21.13% and the minimum value was 1.87%. It was also observed that population growth rate has the lowest dispersion, posting 1.22, followed by public health expenditure with 2.41, GDP growth rate recording 4.83 and unemployment rate has the highest dispersion with the value of 6.55 (Table 2). In the same context, GDP, population unemployment rates are positively skewed while public health expenditure is negatively skewed. Considering kurtosis statistics, only GDP growth is leptokurtic, while other variables are

platykurtic. The probability value of Jarque-Bera test, for GDP growth and unemployment rates are not normally distributed while public health expenditure and population growth rates are normally distributed.

Comparing the GDP and population growth rates of the most and least populous countries in the world, it is observed that on average, most populous countries grow faster than least populous countries in the case of economic activity, since the average growth rate of GDP of the most populous countries was 4.6% while that of least populous countries was 3.81%. However, the statistics indicates that least populous countries grew faster in terms of population than most populous countries, posting 1.57%, on average in contrast to that of most populous countries that was 1.07%. This is not surprising since some most populous countries have embarked on strict birth control to the extent that the growth rate is negative (as supported by the minimum population growth rate). What this suggests is that size rather than rate of growth of population may account for the higher growth rate in GDP of the most populous countries. It is also revealed that on average, least populous countries recorded higher unemployment rate than most populous countries. This also indicates that large size of population may not indicate high rate of unemployment.

4.1. Correlation Analysis

The Pearson Product Moment Correlation Coefficient (PPMCC) was applied to examine the nature of correlation between the pair variables. GDP and population growth rates are positively, albeit, weakly correlated in the most populous countries (Table3). Further, population growth and unemployment rates are positively and moderately correlated. Meanwhile, unemployment and GDP growth rates are negatively correlated, same as the case of public health expenditure and GDP growth rate. Also, public health expenditure and unemployment rates are negatively related. In all, there is no strong (greater than 0.79) correlation in any of the paired variables.

In the case of least populous countries, GDP growth has a positive relationship with both population growth and public health expenditure but has a negative relationship with unemployment rate (Table 3). Further, public health expenditure is positively related to population growth but negatively related to unemployment and lastly, population growth has a negative correlation with unemployment. Like the case of most populous countries, correlation coefficients are not high, and so, the issue of multicollinearity does not arise. Meanwhile, the positive relationship between economic growth and population in the least populous countries tend to be markedly larger than the most populous counterpart. This revelation indicates that population will likely affect growth rate of the most populous and least populous countries differently.

Table 3. Pairwise Correlation Matrix of the Series

country group	Most populous countries					Least populous countries			
Variables	**Grate**	**GCF**	**PHEXP**	**POPGR**	**UNEMP**	**Grate**	**PHEXP**	**POPGR**	**UNEMP**
Grate	1					1			
GCF	0.5959	1							
PHEXP	-0.5459	-0.2736	1			0.106	1		
POPGR	0.0141	-0.0298	-0.1599	1		0.303	0.544	1	
UNEMP	-0.4288	-0.1291	0.3481	-0.3983	1	-0.119	-0.572	-0.499	1

Note: *Grate is growth rate of GDP; GCP is the growth rate of gross capital formation; PHEXP is the share of public health expenditure in GDP, POPGR is the growth rate of population and UNEMP is unemployment rate. Data for GCF is not available for the least developed countries and so, pairwise correlation in relation to GCF cannot be computed. correlation coefficients for any pair of variables are less than 0.79, therefore, there should not be any issue of multicollinearity in the model*
Source: Compiled by the Author

Next is the results of the unit root tests to determine the level of integration that each series is stationary. Two major panel unit root tests commonly employed are the Levin, Lin, Chu (LLC) and the Im, Pesaran, Shin (IPS) unit root tests. The LLC accounts for common root while IPS accounts for individual root. The null hypothesis for the LLC is that there is common unit root process while the null hypothesis for the IPS is that there is individual unit root process. The LLC *t*-statistics with associated probability is used to determine the level at which each series in the panel is stationary. For the IPS, the *W-statistic* is used to determine the level at which individual unit root process is stationary. Results of the tests are shown in Table 4. For the most populous countries, the two tests informs that all the series except public health expenditure are stationary at level with intercept (model I). Public health expenditure is stationary with intercept at first difference. Therefore, both the individual unit root process and common unit root process exhibits a combination of integration at level and at first difference, that is, I(0) and I(1). Unit root tests for the least populous countries is presented in Table 5. The LLC indicate that public health expenditure and unemployment need to be differenced once before the common unit root process is removed, indicating that it exhibits the I(1) process. GDP and population growth rates possess no common unit root process at levels, hence they are integrated of order zero, that is, I(0). Consistent with the result of the LLC, the IPS also suggests that public health expenditure and unemployment rate are differenced once before the individual unit root process can be removed while GDP and population growth rates exhibits the absence of individual unit root process

at levels. However, in contrast to the LLC, population growth rate series has both intercept and trend before the individual unit root process can be removed. Generally, both LLC and IPS for both most populous and least populous countries exhibits a combination of I(0) and I(1).

Table 4. Unit Root Test (Most Populous Countries)

Levin, Lin, Chu Unit Root Test							
	Level			**First Difference**			
Null Hypotheses: common unit root process							
Variables	MODEL I	MODEL II	MODEL III	MODEL I	MODEL II	MODEL III	I(d)
GDPGR	-6.055***	==	==	-----	-----	-----	I(0)
GCF	-5.119***	==	==	-----	-----	-----	I(0)
HEXP	-0.248	-1.318	-0.932	-2.851***	-----	-----	I(1)
POPGR	-3.917***	==	==	-----	-----	-----	I(0)
UNEMP	-1.883*	==	==	-----	-----	-----	I(0)
Im, Pesaran,Shin Unit Root							
	Level			**First Difference**			
Null Hypotheses: individual unit root process							
Variables	MODEL I	MODEL II		MODEL I	MODEL II		I(d)
GDPGR	-4.897***	==		-----	-----		I(0)
GCF	-5.373***	==		-----	-----		I(0)
HEXP	-1.403	-0.473		-5.453***	==		I(1)
POPGR	-3.626***	==		-----	-----		I(0)
UNEMP	-1.978**	==		-----	-----		I(0)

Table 5. Unit Root Test (Least Populous Countries)

Levin, Lin, Chu Unit Root Test							
	Level			**First Difference**			
Null Hypotheses: unit root with common process							
Variables	MODEL I	MODEL II	MODEL III	MODEL I	MODEL II	MODEL III	I(d)
GDPGR	-5.124***	==	==	-----	-----	-----	I(0)
HEXP	0.336	1.470	-0.859	-7.525***	==	==	I(1)
POPGR	2.305	7.784	-3.756***	-----	-----	-----	1(0)
UNEMP	-0.437	-1.255	0.950	-6.351***	==	==	I(1)

Im, Pesaran,Shin Unit Root

	Level		**First Difference**		
Null Hypotheses: unit root with individual unit root process					
Variables	MODEL I	MODEL II	MODEL I	MODEL II	I(d)
GDPGR	-6.236***	==	-----	-----	I(0)
HEXP	0.535	0.632	-6.477***	==	I(1)
POPGR	-4.585*	==	-----	-----	I(0)
UNEMP	-1.126	-1.059	-2.431**	-----	I(0)

*Note: Model I depict intercept, Model II depicts Intercept and trend and Model III depicts ***, ** and * shows the rejection of null hypothesis at 1%, 5% and 10% respectively. The values are the LLC t-statistic and IPS W-statistics respectively*

Source: Compiled by the Author

4.2. Lag Length Selection Criteria

The lag length is determined using Akaike Information Criteria (AIC), Schwarz Information Criteria (SIC) and Hannan-Quin (HQ) information criterion. Table 6 presents different criteria with optimal length order selection. Accordingly, the optimum lag length for model of most populous country is 2 while that of least populous countries is 1.

Table 6. Lag Length Selection Results for Both Most and Least Populous Countries

Country group	**Lag**	**0**	**1**	**2**	**3**	**4**
Least Populous Most populous	**LogL**	-234.41	-224.61	-222.21	-221.98	-221.98
	LR	NA	18.442	**4.472**	5.416	5.009
	FPE	6.401	5.387	**5.242**	5.322	5.428
	AIC	4.694	4.522	**4.494**	4.509	4.529
	SC	4.823	4.676	**4.674**	4.715	4.761
	HQ	4.746	4.584	**4.567**	4.593	4.623
	LogL	-236.27	-235.85	-235.24	-234.62	-233.34
	LR	NA	**0.779**	1.134	1.131	2.295
	FPE	**23.781**	24.133	24.370	24.607	24.444
	AIC	**6.007**	6.021	6.031	6.040	6.034
	SC	**6.126**	6.170	6.210	6.249	6.272
	HQ	**6.054**	6.081	6.103	6.124	6.130

Note: *LogL is loglikelihood; LR means likelihood ratio; FPE means final prediction error; AIC is Akaike information criterion; SC is Schwartz criterion and HQ means Hannan-Quinn information criterion. These are various information criteria used for optimal lag length selection. the longest lag length chosen by any of the information is chosen. All the information criteria chose 2 lags for the most populous countries while LR chose 1 lag (the longest) for the least populous countries while other criteria chose zero lag. Thus, 2 lags and 1 lag is chosen for ARDL models for most populous and least populous countries respectively.*

Source: Compiled by the Author

4.2. Panel ARDL Regression Results

The short run and long run results obtained from the panel ARDL for most populous countries is presented in Table 7. What the table indicates is that population growth has no significant, albeit positive, effect on economic growth. Similarly, there is no immediate short run effect of capital accumulation on economic growth. However, a lagged effect of capital accumulation was found significant and positive on economic growth. This implies that additional physical capital will not have immediate effect on the economic growth of the most populous countries, in the short run. In particular, if the growth rate of physical capital increases by 10% in the previous period, GDP growth rate will increase by 0.4%. This result conforms with that of Ahmadi (2013).

Previous and current unemployment rates have negative and significant effect on economic growth of the most populous countries in the short run. In this case, if unemployment rate falls by10% in the previous period, GDP growth rate will rise by around 2.2%. In the same vein, if unemployment rate falls by 1% in the current period, GDP growth of the most populous countries will increase by around 1 percentage point. This suggests that reducing unemployment rate in the most populous countries is important for economic activity in the short run. Although public health expenditure and population insignificantly affect GDP growth rate, the effect is positive, meaning that both these variables are important for economic growth in the short run. Population would affect economic growth in the short run by 1.05% for a 1% increase in population. It is also observed that previous change in population importantly, even though not significantly enhance current economic growth in the short run. Thus, it can be conjectured that population is crucial to GDP growth of the most populous countries. Gideon et al (2015), and Eli et al (2015) have earlier show that population growth rate creates positive impact on economic growth.

The error correction term in the model determines the speed of adjustment of how the model adjusts quickly to the long run following any shock in the system. The sign and significance of the ECT variable also confirms that there is cointegration among the variables in the panel dataset. The adjustment process is fast, because following any disturbance, may be as a result of fiscal policy that alters public health expenditure, or drastic move to reduce unemployment rate, or move to alter population structure by 10%, 75% of the adjustment process will be attained in the current period while the remaining 25% will be attained in the immediate future. Specifically, it will only take one and a quarter year to adjust to new equilibrium.

Table 7. PARDL Estimation Results (Most Populous Countries)

Short run dynamics Equation (Selected PARDL Model: 1,2,2,2,2)

Variables	Coefficients	Standard Errors	t-statistics
COINTEQ01	-0.75***	0.229	-3.262
D(GCF)	0.06	0.068	0.855
D(GCF(-1))	0.04**	0.018	2.279
D(HEXP)	-1.07	1.168	-0.915
D(PHEXP(-1))	-0.23	0.996	-0.227
D(POPGR)	1.05	1.64	0.639
D(POPGR(-1))	1.28	1.60	0.802
D(UNEMP)	-1.02*	0.573	-1.777
D(UNEMP(-1))	-2.17*	1.169	-1.855
C	-.42*	2.602	1.700
Long run Equation			
GCF	0.36***	0.008	43.792
PHEXP	0.26***	0.026	10.046
POPGR	6.29***	0.37	17.04802
UNEMP	-0.10**	0.051	-2.08795

Note: *Grate is GCF is the growth rate of gross capital formation; PHEXP is the share of public health expenditure in GDP, POPGR is the growth rate of population and UNEMP is unemployment rate. Data of GCF is not available for the least developed countries; COINTEQ01 indicates lagged cointegrating equation coefficient *,**,*** indicate significant at 10%,5% and 1% respectively. Lag length for the model was automatically selected by the estimation package, that is, Eviews 12.*

In the long run, all the variables significantly affect economic growth. Increase in physical capital to the tune of 10% will engender 3.6% increase in economic growth. Public health expenditure also increases GDP growth rate by 2.6% following a 10-percentage increase. Unemployment rate maintains its negative effect on GDP growth of the most populous countries. In particular, a 10% reduction in unemployment rate will lead to 1% increase in GDP growth rate. Hence, GDP growth rate responds faster to changes in unemployment rate in the short run than in the long run.

As far as population growth is concerned, there will be a 6.3% increase in GDP growth rate of the most populous countries if population growth increases by 1%. This could appear ridiculous but it certainly shows the power of population in the economy. Besides, the rapid economic growth of China and India was mainly traced to the large population of these countries. Again, in the US, population plays major roles, both indirectly through the demand side and directly through the application of ever-increasing technological breakthrough. Thus, it is clear that population plays positive and significant role in the world's most populous countries, albeit, it does so in the long run.

Table 8. P-ARDL Estimation Results (Least Populous Countries)

Short run dynamics Equation (Selected PARDL Model: 1,1,1,1)

Variables	Coefficients	Standard Errors	t-statistics
COINTEQ01	0.52***	0.114	-4.545
D(PHEXP)	1.60*	0.919	1.745
D(POPGR)	1.29	1.234	1.042
D(UNEMP)	-5.16	3.745	-1.382
C	5.84***	1.751	3.332
Long run Equation			
PHEXP	0.29*	0.149	1.960
POPGR	1.55***	0.407	3.806
UNEMP	-0.53**	0.191	-2.757

Note: *Grate is GCF is the growth rate of gross capital formation; PHEXP is the share of public health expenditure in GDP, POPGR is the growth rate of population and UNEMP is unemployment rate. Data of GCF is not available for the least populous countries; COINTEQ01 indicates lagged cointegrating equation coefficient; *,**,*** indicate significant at 10%,5% and 1% respectively. Lag length for the model was automatically selected by the estimation package, that is, Eviews 12.*

Results for the least populous countries is presented in Table 8. Only public health expenditure has a positive and significant effect on GDP growth in the short run. In this regard, if public health expenditure increases by 1%, GDP growth rate will rise by 1.6 percentage point in the short run. Population and unemployment rate have insignificant effect. However, population growth rate shows positive effect while unemployment rate shows negative effect. If population growth changes by 1%, GDP growth will rise by around 1.3% while GDP growth will rise by 5.2% for the same percentage decrease in unemployment rate. Following the properties of the cointegrating equation (COINTEQ), it is clear that the system converges to long run. More than 50% of the adjustment to long run will take place in the current period if the system experienced a 100 percent shock from any of the variables. This implies that the system will adjust to long run equilibrium in less than two years following any shock to the system.

In the long run, all the variables have significant impact on GDP growth. Both public health expenditure and population growth rate had positive effect while unemployment rate had negative effect. If public health expenditure rises by 10%, it is expected that GDP growth rate of the least populous counties will rise by 2.9%. similarly, if unemployment rate reduces by10%, GDP growth rate is expected to increase by 5.3 percentage point. Population growth rate is not only important in enhancing economic growth in the least populous countries but also significant. A 1% increase in the growth rate of population will lead to about 1.6% increase in GDP growth rate of the least populous countries.

Comparatively, population maters for GDP growth rates of both most and least populous countries but it matters more for the most populous countries. In other words, population growth is persistent in influencing economic growth of the most populous countries because it has both previous and current effect. This is not the case for least populous countries where only current population growth matters. In addition, in terms of magnitude of effect, economic growth is more sensitive to population growth in the most populous countries than in the least populous countries both in the short and in the long run.

Unlike population however, GDP growth rate responds faster to unemployment rate in the least populous countries than in the most populous countries both in the short and in the long run. This is not unexpected because although population positively and significantly affect growth, a good percentage of most populous countries are also endowed with physical capital (the US, Russia and China). Hence, even if both least and most populous countries raise population by the same 10%, the percentage change, owing to productivity may not be as large as the case of least populous countries.

5. Conclusion and Policy Recommendations

This study carries out a comparative analysis of the effects of population growth in economic growth by considering the six most populous and six least populous countries in the world. Data were collected from 1985 to 2022 and subjected to estimation with the aid of panel autoregressive distributed lag (P-ARDL). The result shows that both in the most populous and least populous, no strong correlation exists between growth rate and all the determinants, that is, physical capital, public health expenditure, unemployment rate and population growth rate. Unemployment rate rose faster in least populous countries than most populous countries. Also, the growth rate of the most populous countries is faster than the least populous countries but the situation is different when it comes to population growth rate. In this regard, the growth rate of population was faster in least populous countries than most populous countries.

Another conclusion that is established from the result is that while population matters for economic growth in the two country groups, economic growth is more sensitive to population growth in the most populous countries. Not only that, population growth is important for growth in the short run in either of the country group but it is more persistent in the most populous countries.

In addition, population is a significant enhancing factor for economic growth in both most populous and least populous countries in the long run. This result is in in line with the findings of Furuoka (2005) who finds positive and significant economic growth in the long run. Hence, being a highly populated country does not necessarily

mean population is inimical to economic growth as predicted by the Malthusian theory. That means Malthusian theory is rejected in this study. In fact, this revelation is buttressed further from the fact that population is more sensitive to economic growth in the most populous country groups than least populous countries, in the long run. Clearly, there is a difference between how population affect economic growth in the most populous countries and least populous country group. A reason for this difference could be the existing technology in some of the most populous countries that are easily adaptable.

Following the findings some recommendations as imperative. Since there is a positive and significant effect of population on economic growth in the long run, a carefully planned population growth strategy coupled with institutional and policy changes could be beneficial to both country groups. This is even important for the most populous countries. One of such plans is to allow for more inflow of people since most of these countries are embarking birth control in order to reduce population. In the case of least populous countries, caution must be exercised in embarking on child-birth control. If this cannot be done, then the countries should come up with policy that will allow inflows of people from another countries (immigration), particularly, the high skill so as to boost the human capital necessary for economic growth of the country group. It is also recommended that the least populous countries should ensure that a considerable size of the population translates to human capital. The result suggests that human capital responds slightly faster to economic growth in the least populous countries than in the most populous countries, thus, it will be beneficial if more share of population is endowed with necessary human capital.

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