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Original Article

Is Population Growth a Requisite for National Economic Growth? A Revisit of the Debate Using Panel Data Analysis

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Abstract: This current paper reassesses the controversial discourse regarding the impact of population growth on national economies using data from 66 countries that constitute 85 per cent of the global population. The panel data spans through the periods 2001-2019. The variables include GDP per capita (regressand), aggregate population, fertility rate, life expectancy, crude death rate and gross fixed capital formation. The fixed effects estimator and panel causality tests were utilized to estimate the data. Findings from the fixed effects model suggests that GDP per capita is adversely and significantly predicted by the aggregate population and fertility rate whereas, gross fixed capital formation and crude death rate exert a positive significant effect on the regressand. Surprisingly, the panel causality result advances that there is a two-way causality between the regressand and the regressors. Following the findings, it is recommended that pragmatic policy measures that will control the rising fertility rate, encourage skill acquisition programs and raise employment generation for the rising population will be a welcome development.

Keywords: Economic growth, aggregate population, panel data, fixed effects model, causality analysis.

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1. Introduction

For more than a century, there have been unending debates among policymakers, economists, demographers, and other scholars regarding the nexus between the growth of national economies and human population. For some authors such as Ukpolo (2002), Li and Zhang (2007), Headey and Hodge (2009), Ogbuabor, Udo and Onuigbo (2018), population growth retards economic growth. To support this view, Creshaw, Ameen, and Christenson (1997) noted that increasing population is responsible for economic unproductivity in less developed nations. Hence, the rising population causes scarce capital to be channeled to the dependent population (such as children), thereby supporting undercapitalization, underemployment, low wages, and weak market demand. Other excellent studies such as Kuznets (1960), Kremer (1993), Peter and Bakari (2018), Hiroyuki, Ni and Sereyyuth (2021), and Maket (2021), noted that population growth is seen as promoting economic growth. To buttress these views, Kremer (1993) noted that globally, expanding economic prosperity is because of population growth. That is, the more people, the more we have investors, scientists, engineers etc., who contribute to invention and technological progress - thus, enhancing economic growth. However, other strands of the subject matter view an insignificant relationship between the two variables, as reported by Dawson and Tiffin (1998), Kelly (1998) and Adenola and Saibu (2017). Till this day, no agreeable results have been reached on the subject matter. These mixed outcomes spur this study.

Particularly, the genesis of the debates between economic growth and population gained greater momentum when Malthus, R. T. (1798) claimed that if the growth of population is unchecked, it will outpace food production. In other words, his notion is that food production will grow arithmetically while population will grow geometrically. Following the work of Malthus, three schools of thought (Optimistic, Pessimistic and Neutralist) emerged on the subject matter (See Akinbode, Okeowo & Azeez, 2017). The optimistic view holds that population is a major determinant of growth, as it boosts the economy's productive capacity via rising labour supply and declining the cost of labour. It is noted that cheaper labour creates room for employers and firms to hire more labour, thereby increasing the productivity and aggregate output of the economy, while unemployment tends to be reduced. For the pessimistic view, the concept of a "population bomb" came into the limelight, as this is attributed to the rapid growth in population. The authors' premises follow the Malthus doctrine of the food supply being outrun by a rising population. They opined that at a point, there would be a scarcity of food for the rising populace, which unresolved would lead to death by starvation. Another argument emerges from the Neutralist school of thought, which posited that population growth has no link or connection with economic development. That is, they believed that the growth of the economy is independent of population growth. Generally, there remains no consensus on whether population expansion is deleterious to promote or is independent of economic growth.

Globally, statistics have shown that Asia is the most populous continent with an estimated population of 4.67 billion people, and her annual population growth rate and fertility rate are estimated as 0.83% and 1.9% respectively. Her purchasing power parity is $14,984 and share of global GDP is the highest (47.48% as at 2021). Next is the African continent with 1.3 billion people, with the highest annual population growth and fertility rates of 2.45% and 4.3% respectively. However, the continent has the lowest PPP per capita GDP of $5,362 and her contribution to World GDP is as low as 4.97% (as at 2021); whereas, the population of Europe is estimated to be 747 million and her annual growth rate of population is 0.01% while her fertility rate stood at 1.5%. Her PPP per capita GDP is $42,279 and her contribution to global GDP is second highest, i.e. 21.73% as at 2021.

(See https://statisticstimes.com/economy/continents-by-gdp.php). From the above statistics, the study can infer that the growth statistics and population indicators differ among regions and there is a need for a recent study of this nature, which includes countries with the largest population in each continent.

In the light of the aforementioned discussion, it is imperative to ascertain if population is a panacea for economic growth from a global perspective. This work is structured into six sections. The introduction and stylised facts are depicted in sections one and two. The literature reviews and research methodology are depicted in sections three and four. Section five depicts the presentation of the results and discussion of findings while the conclusion and policy suggestions are presented in section six.

2. Stylized facts

2.1. Contributions by each continent to global population and gross domestic product.

The information in Figures 1a & 1b depicts each continent's share of population (POP) and GDP as a percentage of the world aggregate for the periods 1970, 2000, 2020 and 2021. Note that, GDP is at purchaser's prices and is obtained from World Development Indicators (WDI, 2021).

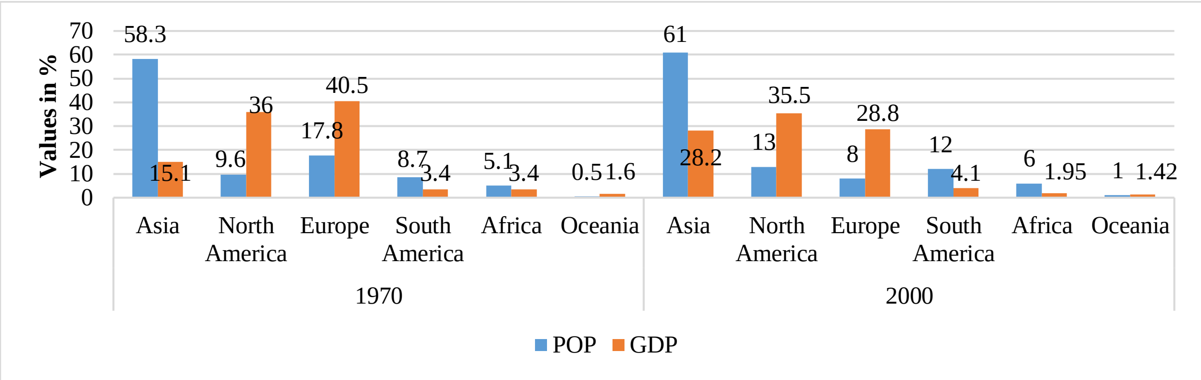

Figure 1a: Percentage shares of global POP and GDP by regions.

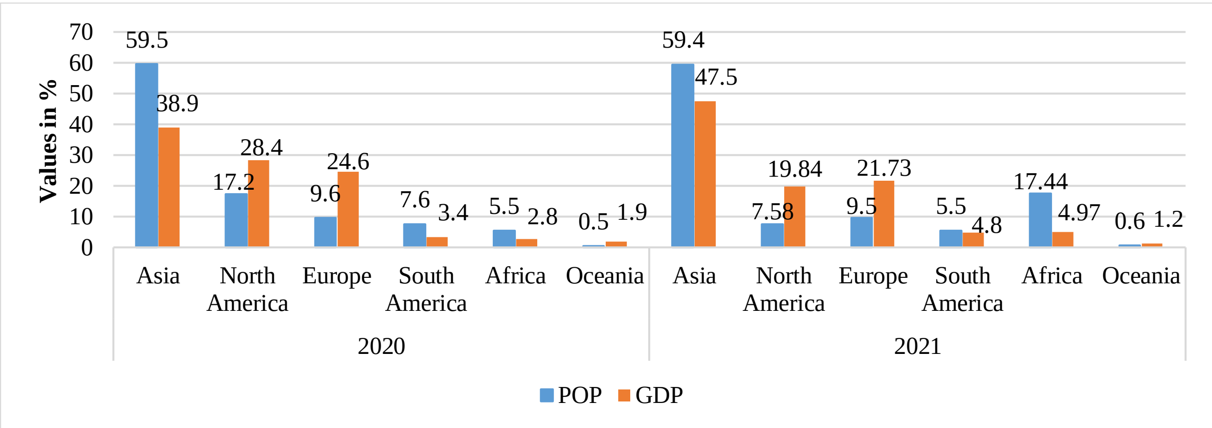

Figure 1b: Percentage shares of global POP and GDP by regions
Source: Authors Computation (2022). Data source: https://statisticstimes.com

Inferred from the graphs (1a and 1b), it can be deduced that the Asian region experiences the largest share of the global population while the lowest is in Oceania. The interesting aspect of the data is that there are mix outcomes between population and the GDP relationship in each of the continents. For instance, as population is increasing or diminishing gradually, the GDP of the five continents is increasing overtime. Only Africa is challenged with a rising population and a declining GDP (see Figures 1a & 1b).

From Figure 2, Africa has the highest annual growth rate of population, given as 2.45%, though with a moderate annual growth rate of GDP in 2021.

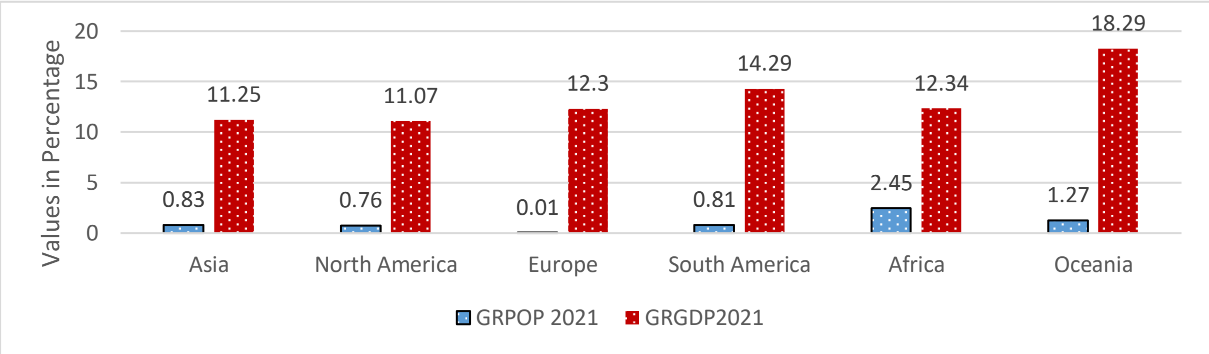

Figure 2: Annual growth rate of POP and annual growth rate of GDP in 2021
Source: Author's Computation (2022).
Data source: https://statisticstimes.com/economy/continents-by-gdp-per-capita.php

In spite of the COVID pandemic, the Oceania continent has the maximum GDP of 18.29% in 2021. The post-COVID effect of the pandemic can be noticed in the GDP growth rate of Asia, North America and Europe (See Figure 2).

3. Theoretical and empirical reviews

3.1. Theoretical literature review

The theoretical underpinnings for this work are: Malthus' population theory, the demographic transition and Neoclassical theories. One of the earliest and renowned population theories is the one put forward by T. R Malthus. Malthus, in his publication, Theory of Population (1798), opined that human beings have a natural sex drive to increase at a geometrical progression, that is, double itself every 25 years, in the form of 1, 2, 4, 8, 16, 32, 64 etc., if unchecked. However, due to the constant supply of land, food supply rises slowly in an arithmetical progression such as 1, 2, 3, 4, 5, 6 etc. His point is, that food supply will be outrun by population growth, consequently causing an imbalance that will bring about over-population. Nonetheless, one of the flaws of this theory is that Malthus never foresaw the technological revolution and agricultural inventions that tackled the problem of constant land supply.

In addition, the Neoclassicals explain the concept of the economic growth and population nexus using labour force growth. They believe that growth in the labour force is essential for economic growth. The common stand is that there exists a direct correlation that takes place concerning development of economies and labour force expansion, which orbits around demand and scale effects. From the perspective of the demand side (the Kuznets cycles), it is noted that population increase is associated with a rise in economic production. This nexus is attributed to increases in the demand for consumable goods as families grow larger or develop (Crenshaw et al., 1997). Drawing from the scale effect, it is noted that labour force growth supports scale effects, viz: more multifaceted division of labour, larger domestic markets, greater volume of skills, technology and information diffusion and low per capita spending, which is associated with public infrastructure (such as ports, roads) because of many users (Crenshaw et al., 1997). In spite of the downsides of the theories reviewed, the strand is that the theories are the building blocks of many empirical studies.

3.2. Empirical literature review

A cursory examination of the subject matter connotes that quite a great number of works have been done in developing and developed nations. For instance, Akintunde, Olomola, and Oladeji (2013), drawing from Malthus's theory, surveyed the issue of changing population and its nexus with growth of economies in 35 Sub-Sahara African nations between 1970 and 2005. The variables were estimated using dynamic panel data analysis and pooled ordinary least square (OLS) techniques. The finding suggests that life expectancy at birth positively impacts on economic growth, while the fertility rate negatively influences economic growth. Based on the outcomes, it is suggested that SSA nations should try as much as possible to address the issue of rising population for sustainable development to be attained. Contributing to the debate, Crenshaw et al. (1997) evaluated the subject matter using 75 emerging nations with panel data obtained from 1965 to 1990. The OLS technique was employed to predict the dependent variable (per capita real gross domestic product). The finding shows that the rising dependency ratio (children's population) impedes an economy's growth, whereas rapid growth of the adult population promotes economic advancement. From the outcomes, it is concluded that the main demographic effect on economic growth is an erstwhile offshoot of the demographic transition.

Using a sample of seven Latin American nations (Brazil, Argentina, Colombia, Chile, Peru, Mexico & Venezuela), Thornton (2001) analyzed the nexus between growth in population and economic growth for the period 1900-1994. Per-capita GDP was employed to measure economic growth (regressand), while population growth was used as the regressor. The findings from the ECM indicate that population growth and GDP per capita do not depict any long-run relationship. Conclusively, the Granger causality result suggests that both variables do not Granger-cause each other. Also, Wong and Fumitaka (2005) utilized 10 Asian economies with data from 1950 to 2000 to determine economic growth and population relationship. The Johansen, Gregory, and Hansen cointegration test shows that both variables are not cointegrated. Findings from the causality test predicted that a bidirectional nexus between both variables in Korea, Japan, and Thailand would be observed while nations such as the Philippines, Singapore, and China were faced with population variable Granger-causing growth only. Meanwhile, the growth variable was noted to cause the population variable to change in Malaysia and Hong Kong without any feedback effect. However, in Indonesia and Taiwan, evidence of causality between both variables was not recorded.

Utilizing 30 nations with the highest population, Sibe, Chiatchoua and Megne (2016) tested the link between GDP per capita (PCGDP) and population growth from 1960-2013. The ECM outcome depicts that PCGDP is positively influenced by population. The Granger causality results suggested bidirectional connection for the two variables. To the contrary, Maestas, Mullen and Powell (2016) with aging population as the predictor and per capita GDP as the predicted variable evaluated how an aging population affected the economies of selected states in the USA for the periods 1980 to 2010. The data was analyzed using a panel OLS technique. The result shows that an aging population has a negative impact on per capita output.

In a like manner, Karim and Amin (2018) assessed the population and economic growth relationship using selected countries (India, Bangladesh, Nepal, Pakistan and Sri Lanka) in Asia with data spanning from 1980 to 2015. The findings of the VECM and Granger techniques illustrated that the population parameter does not significantly predict per capita income; as well, no causal relationship was detected in the end result. Using a dynamic panel approach with 53 nations drawn from the Africa region, Peter and Bakari (2018) investigated how a growing population can affect the aggregate economies of these nations using data within the periods 1980 to 2015. The variables under study include total population, crude birth rate, fertility rate, inflation rate and gross domestic product. The findings from the GMM indicates that population growth positively predicts economic growth, while the fertility rate adversely impacts on the predicted variable. In a related study, Mahmoudinia, Kondelajib and Jafaric (2020), using 34 nations from the Organization of Islamic Conference (OIC), investigated the connection that exists between the subject matter with the inclusion of real stock of capital variable in the model. The data spanned from 1980 to 2018. The outcome depicts a cointegrating relationship among the variables based on the Pedroni cointergration estimation technique. Also, findings from the fully modified OLS, indicates that economic growth is considerably predicted by capital stock and the growth of population. The further results show a bidirectional causality between the two key variables. Furthermore, Shen and Shen (2021) investigated how population change affected the growth of 31 provinces in China by employing data spanning from 2011 to 2019. The first result exhibited a cointegrating relationship among the variables employed; while the second, using the fixed effect estimator, shows that economic growth is positively and significantly predicted by population structure, though there are regional discrepancies in the results. Following the results, the study recommended that there is a need to encourage fertility in order to increase the population of the labour force.

Undoubtedly, it must be noted that examining the link between the core variables from the above-reviewed literature is complex; hence, a recent study such as this, which incorporates the gaps in extant literature, is a welcome development in the fields of development economics.

4. Research methodology

4.1. Theoretical framework and model specification

The theoretical framework and model specification of this work is drawn from the simple classical growth model. In the model, output (Y_{it}) is a function of labour force (L_{it}) and capital stock (C_{it}). The '$_t$' is the time period (2001-2019), and '$_i$' is the cross-sectional units of the 66 countries drawn from the 6 continents.

The model is utilized because of data availability and homogeneity of data across the selected countries. The model is expressed as:

$$Y_{it} = F(L_{it}, C_{it}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1.0)$$

Following the works of Kelley and Schmidt (1995) and Akintunde et al. (2013), where output is said to be influenced by demographic changes while labour force is determined by some key demographic indicators,therefore, the labour variable is technically defined as:

$$L_{it} = F(POP_{it}, LEX_{it}, FER_{it}, CDR_{it}) \ldots\ldots\ldots\ldots\ldots(2.0)$$

Where;

POP: Aggregate population of a country; LEX: Life expectancy at birth; FE: Fertility rate and CDR: Crude death rate.

Drawing from the works of Yang, Zheng and Zhao (2021) and Sayef and Malek (2022), the capital stock variable (C) is measured using gross fixed capital formation (GCF).

That is; $C_{it} = GCF_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.0)$

Incorporating equations 2.0 and 3.0 into equation 1.0, will lead to;

$$Y_{it} = F(POP_{it}, LEX_{it}, FER_{it}, CDR_{it}, GCF_{it}) .... (4.0)$$

Eariler studies such as Crenshaw et al. (1997), Wong and Fumitaka (2005) and Akintunde et al (2013), utilized GDP per capita (PCGDP) to proxy the regressand (output; Y). Therefore, the model for the study is stated as:

$$PCGDP_{it} = F(POP_{it}, LEX_{it}, FER_{it}, CDR_{it}, GCF_{it}) .... (5.0)$$

Taking the Log of each variable, the equation 5.0 can be restated in the econometric form as:

$$LogPCGDP_{it} = \alpha_1 + \alpha_2 LogPOP_{it} + \alpha_3 LogLEX_{it} + \alpha_4 LogFER_{it} + \alpha_5 LogCDR_{it} + \alpha_6 LogGCF_{it} + \mu_{it} .... (6.0)$$

Where 'α_1' is the intercept,and α_2, α_3, α_4, α_5 and α_6 are the regressor parameters of the explanatary variables.

A priori expectation

The a priori expectation is stated as follows:

$$\frac{\partial LogPCGDP_{it}}{\partial LogPOP_{it}} > 0 <, \frac{\partial LogPCGGDP_{it}}{\partial LogLEX_{it}} > 0 <, \frac{\partial LogPCGDP_{it}}{\partial LogFER_{it}} > 0 <, \frac{\partial LogPCGDP_{it}}{\partial LogCDR_{it}} < 0 \ \frac{\partial LogPCGDP_{it}}{\partial LogGCF_{it}} > 0.$$

For clarity purpose, see variables' identification and measurements.

4.2. Variables and measurements

i. Per capita gross domestic product (PCGDP) is the dependent variable. It measures economic growth in the model. See Crenshaw et al. (1997) and Sibe et al. (2016). Data is in current US$.

ii. Aggregate population (POP) is used to capture the total population in each continent. For more details, see the Neoclassical model by Solow (1956), Onuigbo (2018), Kremer (1993) and Maket (2021). Data is in figures.

iii. Life expectancy (LEX) is an indicator that shows the expected years an infant would live throughout his/her lifetime. See Baro (2013), Hansen and Lønstrup (2015). Data in years.

iv. Fertility rate (FER) measures the estimated number of children a woman should bear if she were to live to the end of her childbearing years. See the works of Dao (2012), Peter and Bakari (2018). Data is in percentage.

v. Crude death rate (CDR) is used to capture the number of mortalities that occurs per thousand in a country usually in a year. See Lorentzen, McMillan and Wacziarg (2008), Rocco, Fumagalli, Mirelman and Suhrcke (2021). Data in percentage.

vi. Gross fixed capital formation (GCF) is equally called investment and used to capture capital stock in the study. See Mahmoudinia et al. (2020) and Sayef & Malek (2022). Data is in current US$. Note: All data are sourced from World Development Indicators (2021).

4.3. Sampled countries and estimation techniques

To analyse the population and economic growth relationship, panel data from 2001-2019 were obtained from 66 countries in the six continents of the globe. The six continents constitute 100 percent of the global population (See https://worldpopulationreview.com/continents). From Africa, North America, Asia and Europe, 15 countries were selected. Due to fewer countries and data availability, 9 countries were selected from South America and 7 from the Oceania region. These nations were selected on the ground of population size, as they constitute 85% of the global population (See Table 1). One merit of using panel data is that it gives analysis from the angle of cross–sectional variables and time dimensions (Prada & Cimpoeru, 2019).

Table 1: Sampled countries' population as percentage of total in each continents

Continents	**Countries**	**Population as at 2021**		**Sample population as % of Continent population**
Asia (15 Nations)	China, India, Thailand, Malaysia, Japan, Bangladesh, Indonesia, Philippines, Iran, Saudi Arabia, Iraq, Pakistan, Vietnam, Turkey and Uzbekistan,	Asian	4, 679, 660, 580	90
		Sampled Nations	4, 224, 011, 212	
Africa (15 Nations)	Nigeria, Egypt, South Africa, Algeria, Morocco, Ghana, Angola, DR Congo, Tanzania, Cameroun, Ivory Coast, Uganda, Kenya, Madagascar and Mozambique.	African	1,373,486,472	65
		Sampled Nations	894,182,107	
Europe (15 Nations)	United Kingdom, Russia, Germany, Ukraine, Czech Republic, Belgium, Belarus, France, Italy, Poland, Hungary, Portugal, Netherlands, Spain and Romania.	European	747,747,396	86
		Sampled Nations	639,724,993	
North (15 America Nations)	United States, Mexico, Canada, Honduras, Bahamas, Belize, Cuba, Barbados, Haiti, Costa Rica, El Salvador, Dominican Republic, Guatemala, Jamaica and Panama.	Northern American	596,591,192	98
		Sampled Nations	583,473,099	
Southern America (9 Nations)	Brazil, Bolivia, Argentina, Ecuador, Colombia, Chile, Peru, Paraguay and Uruguay.	Southern American	434,260,138	93
		Sampled Nations	403,863,086	
Oceania (7 Nations)	Australia, New Zealand, New Caledonia, Fiji, Tonga, Solomon Islands and Vanuatu.	Oceanian	43, 219, 954	77
		Sampled Nations	32,965,193	
Aggregate: 6 Continents	66 Countries			85% of Global population

Source: Authors Computation (2022).

The data is estimated using pooled panel OLS, random and fixed effects techniques. For simplicity's sake, only the fixed and random techniques are stated. The fixed effects model for panel data analysis assumed that the regressors have a constant or fixed relationship with the regressand across all time series observations. The fixed effects equation is stated as:

$$\delta_{it} = \beta_i + \alpha_1' \varpi_{1it} + \alpha_2' \varpi_{2it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7.0)$$

Where: δ_{it} is the regressand; β_i is the unknown intercept for each country (which captures the fixed effects that the model is all about), α_1 α_2' are coefficient of regressors, ϖ_1 ϖ_2 are regressors and ε_{it} is reported as a random disturbance term. Hence, the 'i' is a series of numbers such as 1, 2, 3, 4, 5, 6..., N countries and the time periods 't' takes the form of 1, 2, 3, 4, …T.

Thus, it must be noted that the fixed effects model does not face a heterogeneity bias issue because its estimation is within effects. Similarly, the random effects model assumes that the discrepancies between entities/individual countries or continents are random. The model for each individual continent 'i' at time 't' is given as;

$$\delta_{it} = \beta_i + \alpha_1^{'} \varpi_{1it} + \alpha_2^{'} \varpi_{2it} + \mu_i + \varepsilon_{it} \quad (8.0)$$

In equation 8.0, the random effects model incorporates 'μ_i', a random variable that varies across individual countries or continents. The random term is believed to possess a constant variance and a mean that is zero, which is like that of the error term. Furthermore, it is assumed to be uncorrelated with the regressors in the model/regression.

Furthermore, the Hausman and Wald tests are carried out to see which estimator is the best for the study. Prior to the aforementioned tests, the variables are subjected to difference unit root tests to see if the data in question are stationary at difference levels. These tests are Im, Pesaran and Shin (1997), Levin, Lin and Chu (2002), PP Fisher Chi-Square and ADF- Fisher chi-square stationarity techniques. Thereafter, The Pedroni's procedure, which allows for the presence of cointegration among the selected variables, is carried out. Lastly, the causality test among the variables is tested. Thus, the Granger causality test is estimated using a bivariate regression in a panel data as stated below:

$$\infty_{i,t} = \beta_{0,i} + \beta_{1,i} + \infty_{i,t-1} + \ldots\ldots + \beta_{1,i} \infty_{i,t-1} + \omega_{1,i} \phi_{i,t-1} + \ldots. + \omega_{1i} \phi_{i,t-1} + \varepsilon_{i,t} \quad (9.0)$$

$$\phi_{i,t} = \beta_{0,i} + \beta_{1,i} + \phi_{i,t-1} + \ldots\ldots + \beta_{1,i} \phi_{i,t-1} + \omega_{1,i} \infty_{i,t-1} + \ldots. + \omega_{1i} \infty_{i,t-1} + \varepsilon_{i,t} \quad (10.0)$$

From equations 9.0 and 10.0, the Granger (1969) approach is to see whether ∞ causes ϕ, and how much of the current values of ϕ can be predicted by the previous values of ϕ likewise to see if the added lagged value of ∞ can improve the explanation. It is noted that ϕ is Granger caused by ∞, if ∞ can assist to predict ϕ, or equally when the coefficients of the lagged ∞ is statistically significant.

5. Presentation and discussion of results

5.1. Descriptive statistics

Table 2 shows the summary statistics of per capita income (PCGDP), total population (POP), annual growth rate of population (GRPOP), life expectancy (LEX), fertility rate (FER), crude death rate (CDR) and gross fixed capital formation (GCF) of the sampled countries. The mean of PCGDP is \$11370.57 (Table 2), this is less than the WDI estimated of mean PCGDP (\$12,262.9) in 2021 (WDI, 2021). The mean population is 79,126,786. From our (1-5) result, the annual population growth rate (1.304%), fertility rate (2.732) and CDR are higher than the WDI estimate of 0.9%, 2.4% and 7.706% of 2020 and 2021 publications; while life expectancy (71.52) is less than the WDI value of 72.7 years. The economic implications of rising GRPOP, high CDR, low LEX and low PCGDP when compared with the WDI estimate shows the adverse nexus between the explanatory variables and economic growth.

Thus, the skewness information revealed that all the variables are positively skewed, except life expectancy. The kurtosis estimate suggests that the GRPOP distribution exhibits a platkurtic curve while the other variables exhibit leptokurtic curves as the estimated values are greater than 3. Based on the probability values of the Jarque-Bera statistics, it can be deduced that all the variables are not normally distributed.

Table 2: Descriptive statistics for each continent

	PCGDP	POP	GRPOP	FER	LEX	CDR	GCF
Mean	11370.57	79126786	1.305	2.732	71.519	7.963	183000000000
Maximum	68156.63	1410000000	3.896	6.800	84.356	18.600	6120000000000
Minimum	153.591	98482	-1.854	1.078	46.510	3.407	20744429
Std. Dev.	14403.07	207000000	1.019	1.337	8.035	3.001	565000000000
Skewness	1.628	5.290	0.107	1.190	-1.028	1.028	6.134
Kurtosis	4.602	31.253	2.497	3.545	3.579	3.521	46.535
Jarque-Bera	792.529	54762.56	18.003	358.801	274.703	270.553	123090.2
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	1444	1444	1444	1444	1444	1444	1444

Source: Author's computation (2022).

Table 3: The pooled unit root results

	Test Types	LOGPCGDP	FER	LOGPOP	LEX	CDR	LOGGCF
SIX CONTINENTS	Levin, Lin & Chu t*	-14.314	-14.824	-17.157	-29.994	-27.148	-11.507
	Im, Pesaran & Shin W-stat	-9.395	-6.639	-11.7611	-16.564	-12.101	-6.195
	ADF - Fisher Chi-square	359.596	981.362	1126.1	1254.8	1428.6	278.507
	PP - Fisher Chi-square	550.026	1591.53	2795.76	1000.94	879.43	265.618
	INTEGRATED ORDER	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)

Source: Author's computation (2022).

5.2. Other empirical tests

Table 3 shows the unit root tests for the whole continents. The pooled continents data shows that all the variables exhibit stationarity at level, which is an integrated order of zero; I (0).

Table 4 is the Pedroni residual cointegration results to check the possible existence of cointegration between the regressand (PCGDP) and the regressors. The decision rule is that we compare the number of estimated p-values that is greater and lesser than the 5% critical value. If we have more p-values that are lesser than the 5% critical value, then we reject the null hypothesis that there is no long-run relationship that exists among the variables.

Table 4: Pedroni residual co-integration test (For the Whole Continents).

Included observations: 1444					Cross-sections included: 76		
Null Hypothesis: No cointegration					Trend assumption: Deterministic intercept and trend		
User-specified lag length: 1							
Newey-West automatic bandwidth selection and Bartlett kernel							
Alternative hypothesis: common AR coefs. (within-dimension)					Alternative hypothesis: individual AR coefs. (between-dimension)		
	Statistic	Prob.	Statistic	Prob.		Statistic	Prob.
Panel v - Statistics	-5.280	1	-12.722	1	Group rho-Statistic	13.064	1
Panel rho-Statistic	9.761	1	9.535	1	Group PP-Statistic	-35.723	0.000
Panel PP-Statistic	-14.865	0.000	-33.213	0.000	Group ADF-Statistic	-14.243	0.000
Panel ADF-Statistic	-12.197	0.000	-17.543	0.000	Cross section specific results		

Source: Author's computation (2022).

From the result in Table 4, it can be deduced that there are more p-values less than the 5% critical value. Therefore, we (1-5) accept the alternative hypothesis that there is a long-run relationship between PCGDP and the explanatory variables. This finding is supported by the results of Mahmoudinia et al. (2020), Shen and Shen (2021), but contrary to the work of Thornton (2001) and Karim and Amin (2018).

Based on the above outcome (Table 4), the next task is to use both Hausman and Wald tests to determine which tests (pool, fixed or random effects) are appropriate for the study. Thus, for the Hausman test, if the probability value of the estimated parameter is less than 5%, then we reject the null hypothesis, which states that the random effects model is appropriate. Therefore, we accept the alternative hypothesis, which states that the fixed effects model is appropriate. For the Wald technique, if the estimated probability value is less than 5%, then the null hypothesis is rejected. The decision rule is that the fixed effect model is more appropriate for the empirical analysis. A crucial look at Table 5 shows that the estimated Hausman and Wald tests are lesser than the 5% critical level. The decision rule is that the fixed effect estimator is more appropriate than the random effects and pooled regression models.

Table 5: Estimators selection criteria

	Hausman Test; Correlated Random Effects. Test cross-section random effects			
	Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
WHOLE CONTINENTS	Cross-section random	428.017	6	0.000
	Wald Test:	Value	df	Prob.
	F-statistic	54.611	(6, 1361)	0.000
	Chi-square	327.669	6	0.000

Source: Author's computation (2022).

So far, the equation (6.0) serves as the model for carrying out the empirical analysis in Table 6. In discussing the empirical outcome in Tables 6, we need to understand the rule of thumb for spurious regression results. The rule states that when the coefficient of determination (R^2) is greater than the Durbin-Watson statistics, this implies that the regression outcome is spurious. From the finding of the fixed effects test (in Table 6), the R-squared is less than the Durbin-Watson statistics; therefore, the regression result is free from any spuriousness problem.

Drawing from the result, the key variable: total population (LOG(POP(-1)), is negatively related to per-capita gross domestic product (PCGDP), and statistically significant at 1% in impacting on the regressand (PCGDP). This implies that an increase in population growth will bring about a decline in economic growth (PCGDP). Quite a number of factors are responsible for this outcome, but two key ones are a rising dependency ratio above the economic active population and an increasing unemployment rate. rising dependency ratio and unemployment rate implies a smaller economic active population contributing to productive activities, which might have an adverse effect on the economic performance of any nation. In Europe and other developed countries, the issue is a growing aging population, which implies a rising dependency population. While in most developing regions such as Africa, the issues are rising unemployment and poverty rates, and corruption coupled with an increasing population. This might be the main reason why population growth negatively predicts PCGDP. The negative relationship between the two variables corroborates the works of Maestas et al. (2016) and Chowdbhury and Hossain (2018) but does not support the findings of Peter and Bakari (2018) and Shen and Shen (2021).

Table 6: Panel regression result

	POOLED OLS			FIXED EFFECTS MODEL			RANDOM EFFECTS MODEL		
	Coeff	Std Error	Prob.	Coeff.	Std. Error	Prob.	Coeff	Std. Error	Prob.
C	0.402	0.082	0.000	4.731	1.065	0.000	0.402	0.072	0.000
LOG(PCGDP(-1))	0.859	0.009	0.000*	0.697	0.014	0.000*	0.859	0.008	0.000*
LOG(POP(-1))	-0.113	0.008	0.000*	-0.403	0.068	0.000*	-0.113	0.007	0.000*
LEX	0.001	0.001	0.174	-0.001	0.003	0.792	0.001	0.001	0.120
FER	-0.011	0.005	0.018*	-0.097	0.018	0.000*	-0.011	0.004	0.007*
CDR	0.007	0.001	0.000*	0.010	0.005	0.031*	0.007	0.001	0.000*
LOG(GCF)	0.110	0.008	0.000*	0.206	0.010	0.000*	0.110	0.007	0.000*
R-Squared	0.994			0.996			0.994		
F-statistic	37482			3638.6			37482		
DW- stat	1.375			1.501			1.375		

Source: Author's computation (2022).

In addition, the life expectancy variable has a negative significant impact on PCGDP. This implies that a rise in life expectancy will cause PCGDP to decline in the continents. This outcome is contrary to the finding of Rashidu, Golam, Ripter, Nuru and La (2013), but validates the works of Hakeem et al. (2016) and Akintunde et al. (2013) that found PCGDP to be adversely predicted by LEX in their studies. Equally, the fertility rate has a significant impact on the outcome variable though negative. This implies that an increase in FER by 100 percent will cause economic growth to decline by 9.7 percent. This result supports the works of Dao (2012), Peter and Bakari (2018), who believe that a rising FER will increase the dependency ratio and depress PCGDP. Also, the number of deaths per thousand (CDR) does not have a substantial effect on PCGDP (Table 6). As the result predicts that as CDR is increasing, PCGDP will continue to rise.

Table 7: Causality tests using Dumitrescu Hurlin methods

Sample: 2001 2019	Lags: 2			Results
The Null Hypothesis forms:	W-Stat.	Zbar-Stat.	Prob.	
LOG(POP) does not homogeneously cause LOG(PCGDP)	5.911	10.415	0.000	↔
LOG(PCGDP) does not homogeneously cause LOG(POP)	15.709	39.472	0.000	
LEX does not homogeneously cause LOG(PCGDP)	4.946	7.552	0.000	↔
LOG(PCGDP) does not homogeneously cause LEX	16.214	40.969	0.000	
FER does not homogeneously cause LOG(PCGDP)	4.019	4.802	0.000	↔
LOG(PCGDP) does not homogeneously cause FER	19.424	50.492	0.000	
CDR does not homogeneously cause LOG(PCGDP)	4.272	5.554	0.000	↔
LOG(PCGDP) does not homogeneously cause CDR	11.454	26.854	0.000	
LOG(GCF) does not homogeneously cause LOG(PCGDP)	3.349	2.815	0.005	↔
LOG(PCGDP) does not homogeneously cause LOG(GCF)	3.617	3.610	0.000	

Note: Bidirectional causality (↔), unidirectional causality (→) and no causality (Χ)

Source: Author's computation (2022).

Interestingly, the coefficients' gross fixed capital formation (GFCF) positively and significantly predicts PCGDP. Globally, this explains the importance of gross domestic investment in boosting economic activities and purchasing power. This result is supported by the work of Mahmoudinia et al. (2020), Sayef and Malek (2022). A brief glance at the F-statistics (3638.6), suggests that the results typically explain the model. That is, all the regressors jointly and significantly explain changes in PCGDP.

The direction of causality using the Dumitrescu Hurlin procedure was tested between PCGDP and the regressors (Table 7). This test was carried out due to the cointegration relationship among the variables.

In sum, the result indicates that there is a bidirectional causality between the regressand (LOG(PCGDP)) and all the regressors (LOG(POP), LEX, FER, CDR & LOG(GCF)). This is because the probability values of the estimates are less than 5% critical value. The bidirectional causality between the key variables; LOG(PCGDP) and LOG(POP) is supported by the works of Kremer (1993), Sibe et al. (2016) and Wong and Fumitaka (2005). As noted by Kremer (1993), the bi-causal relationship between the population variable and the growth variable shows that population is the driving force of development. However, this current result is not in line with the results of Thornton (2001), Karim and Amin (2018) that found no causal effect between both variables.

Decisively, one possible reason for the result between the core variables as depicted in Table 7, is because increases in population growth might have a significant effect on economic growth, but the effect might be adverse. The reason is because there are many other variables that influence economic growth which can significantly cause population growth to change.

6. Conclusion and policy recommendations

This research paper is a revisit on the debate on whether population influences or does not influence the growth of national economies. The aim of this work is achieved with the aid of 66 countries that constitute 85 percent of the total global population. The countries were drawn from six continents, which made up 100 percent of world population and the panel data span was through 2001-2019. The variables include per capita GDP (to measure economic growth), population growth, crude death rate, fertility rate, life expectancy, and gross fixed capital formation. The data were retrieved from WDI and mainly analyzed using the Pedroni residual cointegration test, Hausman and Wald tests, panel OLS and fixed and random effect estimators, likewise the Dumitrescu Hurlin panel causality tests. The outcomes from the cointegration techniques established that both the regressand and the explanatory variables are cointegrated. The empirical result from the fixed effects model suggests that only life expectancy does not exert significant impact on economic growth. Both total population and fertility rate negatively predict PCGDP while lagged PCGDP, CDR and GCF exert positive effects on national economies. The panel causality tests suggest that there is a two-way causal relationship between the LOG(PCGDP) and all the regressors.

The important lesson to draw from the fixed effects result is that both FER and POP are connected, drawing from the negative effects on PCGDP. Thus, if, there is no moderate growth in both variables, there is the likelihood that economic growth will be adversely affected. Relating these results to policy options for developing countries such as Asia and Africa, we (1-5), suggest that workable policy measures that will control fertility rate, encourage skill acquisition programs and employment generation for the rising population will be a welcome development. These strategies will not only boost the productivity of the rising labour force, but increase the GDP growth rate, per-capita income and perhaps raise the living standard of the populace. For the developed continents such as Europe, North America, Oceania etc., where aging populations and the dependency ratio is growing faster, there is the need to ease or apply a less restrictive migration policy. This is to encourage highly skills and productive youth to migrate to the continents in order to augment the aging population, boost the labour force and raise productivity. In turn, this measure will enhance the rate of economic growth. Furthermore, it is popularly said, "a healthy population is a productive population"; therefore, there is the need for more investment in infrastructural facilities such as a good health system and a sound educational structure at an affordable price, which will promote population health as well as growth in both emerging and industrialized nations. In conclusion, it must be noted that demographic variables in the form of population have an adverse and significant effect on the economies of the countries under study.

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