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Article

The Short and Long Run Impact of Population Growth and HIV Incidence on Gross Domestic Product and Per capita Gross Domestic Product in Selected African Countries

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Abstract: Africa is expected to have the lion's Share of the world's population growth by the year 2050. At the same time, the World Health Organisation (WHO) reported that roughly 3.4 percent (1/25) of African adults live with HIV making the contient the most severely affected by the HIV pandemic. Consequently, this study, the first of its kind, investigates the impact of population growth and HIV incidence on economic growth and economic development in Africa by utilizing the Pooled Mean Group (PMG) estimator on data from 1990 to 2020 across 29 countries. The results show that population growth has a postive long run impact on Gross Domestic Product (GDP) but has a negative long run impact on per capita GDP, albeit the effects are insignificant in the short run. The incidence of HIV has a negative long run impact on both GDP and per capita GDP although its effect is not significant in the short run. The study, therefore, calls for the advancement of family planning practices and the usage of contraceptives to simultaneously control population growth and curb the spread of HIV incidence. The study futher calls for African governments to increase budgetary allocations in the health and education sectors, as these policy perspectives have the potential of increasing the human capital stock while at the same time enhancing the health status of the work force for sustained growth and development.

Keywords: population growth; HIV/AIDS; GDP; per capita GDP; PMG

1. Introduction

The global population is expected to have around 8 billion inhabitants by the 15th of November 2022 (United Nations, 2016). Futher, the world population will stretch to around 8.5 billion by the year 2030 and will eventually reach 9.7 billion by 2050. Between 2022 and 2050, the total number of people in Sub Saharan Africa (SSA) is expected to almost double, going beyond 2 billion inhabitants by the late 2040s. Shrinking mortality rates, fertility rate increments, improved life expectancy, better methods of producing food as well as improved health care are some of the factors linked to this explosive population growth. In most cases, in developing economies particularly those in Africa, growing populations trigger the availability of both workers and consumers, and at the same time expand opportunities for young people. On the contratry, Peterson (2017) views population growth in under developed nations as a catalyst for stunted economic growth because it creates social problems such as income inequality, poverty and also limits people's access to resources. Furthermore, rapid population growth devastates productivity in low income states by depreving investments ventures in capital intensive sectors and therefore negatively affects economic growth and sooner or later eludes the much needed economic development.

Globally, around 30.4 million people were living with HIV/AIDS by the end of 2021 according to calculations from the World Health Organization (WHO) 2021 report. Futhermore, roughly 3.4 percent (1/25) of African adults were living with HIV/AIDS making

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the contient the most severly affected by the HIV/AIDS pandemic, and globally adjudge for more than two thirds of people living with HIV. Additionally, a projected 860 000 people acquired HIV in 2021 and new infections among all ages declined to 0.78 out of 1000 uninfected population in 2021 from 0.86 in 2020. According to Were and Nafula (2021), HIV prevalence has become a consequential development crisis with unfavorable repercusions in the health sector having a trickle-down effect on other areas such human resource, manufacturing, education, industry, agriculture, transport and the economy in general. Such a problem may be catastrophic if left unchecked more especially that SSA has the fastest growing population in the world. Between 2022 and 2050, average fertility rates are expected to persist around 3 births per woman. Thus making SSA to register more than half of the growth in human inhabitants on planet earth by 2050 (WHO,2021).

The theoretical linkage between population growth and economic growth may be explained by the Solow growth model. As explained by Todaro and Smith (2010), this theory connects population growth to economic growth by explaining that increase in the labor force has a positive effect on economic growth. Some major criticisms againist this theory are that it does not distinguish the different forms of human capital and it lacks micro-economic foundations. The theoretical linkage between population growth and economic growth may also be explained through the Malthusian population trap. This theory suggests that a growth in agricultural production will lead to population growth, but as the population grows, the land can no longer support the growing population meaning that there should now be mechanisms in place to control population growth. If these mechanisms are not put in place, famine, war and disease will prevail and eventually lead to a decrease in population (Todaro and Smith, 2010). However, modern scholars have criticized the theory by pointing out that Malthus failed to take into account developments in technology for agricultural production which will help cater for the growing population.

This study, first of its kind, will contribute to the body of knowledge by comparing the short and long run impacts of HIV incidence and population growth on Gross Domestic Product (GDP) with those on per capita GDP. The study will also shed more light on the mixed and inconclusive findings on the nexus between population growth and economic growth / population growth and economic development. On one hand, some authors such as Klasen and Lawson (2019) and Chowdhury et al. (2018) found a negative relationship of population growth and economic growth. On the other hand others such as Furuoka (2009), Tadese (2020), Sibe et al. (2016), Kiguru and Thuku (2013) and Mamingi & Perch (2013) found a positive impact.

According to Pesaran and Smith (1995), panel data faces the problem of aggregation where the estimates may become biased especially when the slope parameters are allowed to change across different cross sections. To avoid this problem, the study adopted the Dynamic Autoregressive Distributed Lag (ARDL) panel model known as the Pooled Mean Group (PMG) estimator. This model is well suited for panel data sets containing a combination of I (1) and I (0) orders of integration. Futher, the model is also suitable when the time dimension (T) is greater than the number of cross sections (N) which makes it possible to avoid the bias in the average of the estimators and solves the problem of heterogeneity.

The rest of the paper is structured as follows; a review of the theoretical and related empirical background on population growth, incidence of HIV, economic growth and economic development nexus in the second section ; the third section brings out the method of analysis, variables, and sources of data ; the fourth section discusses the estimation techniques; while the fifth section presents the results ; the sixth section outlines the discussion of results; and the final section seven, highlights the conclusion and policy directions.

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2. Empirical Literature Review

This section presents the previous empirical discussions on population growth, HIV/AIDS and economic growth/development nexus both within and outside Africa. The review is based on two main ideas; the impact of population growth on economic growth and economic development, and the impact of HIV/AIDS on economic growth and economic development.

2.1. The Impact of Population Growth on Economic Growth and Economic Development

The impact of population growth on economic growth and economic development comes with mixed and inconclusive scholarly submissions. For instance, Klasen and Lawson (2019) used Autoregressive Distributed Lag (ARDL) to study the impact of population growth on economic growth and poverty reduction in Uganda. Findings reveal that, population growth influences economic growth negatively and worsens poverty. Correspondingly, Chowdhury et al. (2018) used Ordinary Least Squares Method (OLS) to study the link between population growth and economic development in Bangladesh. Evidence shows that population growth affects economic growth negatively in Bangladesh. On the contratry, Ali et al. (2013) studied the impact of population growth on economic development in Pakistan from 1975-2008 and employed Autoregressive Distributed Lag (ARDL) technique which revealed that there is a positive relationship between population growth and economic growth. Similarly, Furuoka, (2009) found that there is a positive relationship between population growth and economic performance in Thailand while utilizing the bounds test to analyse the long run relationship between population growth and economic development in Thailand.

In a similar study, Tadesse (2020) used the Autoregressive Distributed Lag Model to investigate the relationship between economic growth and population growth in Ethiopia from 1975 to 2019. Evidence discloses that population growth limits real GDP in the short run but boosts it in the long run. Correspondingly, Peter (2018) examined the impact of population growth on economic growth in 53 African countries between 1980 and 2015 using Dynamic panel models of difference and system GMM. The results show that an increase in population has a positive effect on economic growth. Analogously, Sibe et al. (2016) used the Error Correction Model to investigate the relationship between population growth and economic growth in the world's 30 most populated countries from 1960 to 2013. Findings divulge a long-run equilibrium connection between population growth and economic growth. The Granger causality test revealed that economic growth and population growth are bi-directionally related. Likewise, Tartiyus et al. (1980) evaluated the impact of population growth on economic growth in Nigeria using secondary data from 1980-2010. Ordinarly least squares regression was used and the results revealed that there is a positive relationship between economic growth and population growth.

In another similar study, Thuku and Gachanja (2016), sought to establish the relationship between population growth and economic growth using the Vector Auto Regression Estimation technique on annual time series data from 1963- 2009 in Kenya. The results highlighted the that population growth positively impacts economic growth. Additionally, Mamingi and Perch (2013) examined the relationship between population growth and economic growth in the period between 1980-2010. Using the Autoregressive Distributed Lag Approach to cointegration, the results showed that population growth and population density positively affects economic growth and that economic growth negatively affects population growth.

Moreover, John (2001) used the Johansen Maximal likelihood and Granger causality tests to analyze the long-term relationship between population and per capita GDP over the majority of the 20th century in seven Latin American countries. Findings implied that there was no long-term relationship, and as a result, population increase neither influences nor is influenced by rise in per capita GDP. On the contrary, in Pakistan Afzal (2009) examining population growth and economic development using multivariate analyses of 1981 to 2005 data from Pakistan, discovered a negative correlation between population

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growth and indicators of economic progress. These findings showed that Pakistan's high population increase is a serious issue since it lowers investment growth and lowers the savings rate.

In another study, Peterson (2017) also examines the link between population growth, growth in per capita output, and overall economic growth over the past 200 years through a review of the theoretical and empirical analyses. Results indicated that, high population growth in low-income countries may hinder their progress, while low population growth in high-income countries is likely to cause social and economic issues.

Correspondinly, Loiboo et al. (2021) used the Vector Auto-regression (VAR) estimation technique and annual time series data from 1971 to 2017 to study the link between population growth and economic growth in Tanzania. The findings show that population growth has a positive impact on economic growth. Karim & Amin (2018) conducted a similar study in which they used Ganger Causality tests and Vector Error Correction Model (VECM) to investigate the relationship between population growth and economic growth in five South Asian Countries for the period between 1980 and 2015. Findings indicated that population and its strength have no effect on the economic growth. The results of the Granger causality test on the other hand revealed that there is no relationship between population growth and economic growth. Likewise, Onogiese et al. (2022) used panel data to examine the effect of population growth on economic growth in 66 countries between 2001 and 2019. In the analysis, the fixed effects estimator and panel causality tests were used. The fixed effect estimator results show that aggregates population predicts GDP per capita whereas the panel causality test revealed that population growth affects GDP per capita and vice versa.

Comparably, Dao (2012) used the least-squares estimation technique to study population and economic growth in 43 developing countries. He found a positive relationship between economic growth and population growth. Kuhe (2019) studied the effect of population growth on economic growth in Nigeria using the Dickey-Fuller Generalised least squares unit test, Engle-Granger residual based cointegration test, fully modified least squares, error correction model and VAR Granger causality test. His findings revealed that population growth has a positive effect on economic growth in the long run whilst it is temporary in the short run. Similarly, Ochinyabo (2021) also studied the impact of population growth on economic development in Nigeria, covering a period of 15 years from 2006 to 2019. Contrary to the findings of Kuhe, Ochinyabo found a negative relationship between the two.

2.2. The Impact of HIV/AIDS on Economic Growth and Economic Development

The link between HIV/AIDS and economic growth has equally been investigated by several scholars. Their findings indicate that HIV/AIDS limit economic growth, for instance Amponsah et al. (2019) conducted research using 2000 to 2015 data from 46 Sub-Saharan African countries. The system-generalized method of moments estimation was used. Findings reveal that, a 1% increase in HIV/AIDS prevalence leads to a 0.47% decrease in per capita income. Homogenously, (Sunday et al., 2017) used annual time series data from the World Bank, Central Bank of Nigeria, and multiple regression model to assess the impact of HIV/AIDS on Nigerian economic growth from 1990 to 2015. Findings show that, HIV/AIDS negatively affected productivity and, as a result, economic growth.

In another related study, Essig and Kang (2015) examined the relationship between HIV infection rates and GDP per capita in African countries. After constructing a simple regression model with data from 2005 GDP per capita and the number of adults and children living with HIV as independent variables, the results revealed a weak correlation. However, after modifying the model by including multiple independent variables such as HIV/AIDS deaths, arable land per capita, labour force, foreign direct investment percentage, life expectancy, exports, and people living with HIV, the results revealed HIV/AIDS negatively impacts the country's economy.

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In addition, Onyeka and Diyoke (2019) utilized cross-country data using Dynamic System GMM Estimates series of 18 countries in SSA from 1986-2017 to empirically examine the impact of HIV/AIDS on economic growth. The results showed that an increase in the prevalence of HIV/AIDS, not only affects human capital development negatively but also output growth in the region. Furthermore, a study by Gezahegn and Upadhyay (2014) with an aim to investigate the effect of health on overall economic growth in southern Africa used generalized least squares estimation of panel data models, suggested HIV/AIDS negatively affects the accumulation of human capital and thus slows down growth of per capita income.

In Nigeria, Maijama'a and Kachalla (2013) studied the effects of HIV/AIDS on economic growth using both time series data and primary data. The study revealed that HIV/AIDS has a negative effect on economic growth as it impacts GDP growth negatively. Bloom & Mahal (1997) on the other hand concluded that the AIDS epidemic has very little impact on per capita income growth rate. This finding was based on data from 51 industrial and developing countries.

In a similar study, Bonnel (2000), using Cross-country regressions for the period between1990-1997 revealed that HIV/AIDS reduced the rate of growth of Africa's per capita income by 0.7 percentage per year. Similarly, while investigating the relationship between AIDS and economic growth of 17 African countries for the period 1990 to 1996 using pooled time series, Ukpolo (2004) found a significantly negative relationship between AIDS and economic growth. Additionally, HIV/AIDS decreased economic growth and exacerbated poverty, both of which speed up the spread of HIV. While an inconclusive study by Dixon et al. (2001) aimed at analyzing how the HIV epidemic affected the growth of 41 African economies between 1960 and 1998 using panel data, results showed that it is unclear how an outbreak would affect the macroeconomic climate when its prevalence is reasonably high.

Waziri et al. (2015) used a dynamic approach to investigate the impact of HIV/AIDS and life expectancy rates on economic growth in SSA countries between 2002 and 2012. Results indicated that increase in HIV prevalence has a negative impact on these countries' economies. Similarly, from 2005 to 2009, Igwike & Hussain (2013) used a random effect model to establish a link between economic growth and HIV prevalence in 40 SSA countries. Findings show that, HIV/AIDS has a negative effect on the economic growth of these countries, with countries having the highest per capita income showing an inverse relationship compared to those with lower and medium per capita income. Furthermore, Olaniyi and Adudu (2018) used the Vector Error Correction Mechanism (VECM) to examine the effect of HIV/AIDS on Nigerian economic growth between 1990 and 2016, and the results show that HIV/AIDS limits economic growth.

3. Method, Variables and Data Sources

This study utilizes the Pooled Mean Group (PMG) model on panel data for the period between 1990 and 2020 for 29 selected African countries, to determine the impact of population growth and HIV incidence on Africa's economic growth and economic development. The proxy for economic growth is the log of Gross Domestic Product (lnGDP), while the proxy for economic development is the log of Gross Domestic Product Per Capita (lnGDPPC). The main independent variables are Population growth and HIV. Annual population growth is used as a proxy to represent population growth, apriori we expect a positive result on GDP and Per capita GDP. Similarly, HIV is measured by the proxy of HIV incidence, apriori we expect a negative result on GDP and Per capita GDP. The control variables used in this study are Foreign Direct Investments (FDI) and Inflation. We expect FDI to have a positive impact on GDP and Per capital GDP while inflation is anticipated to have a negative impact on both GDP and per capita GDP. All the variables, descriptions, sources, function and expected signs are summarized in table 1 below.

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Table 1. Variables, Description, Sources, Function and Expected signs.

Variable	Description	Source	Function	Expected Sign
LnGDP	Log of Gross Domestic Product	World Bank	Dependent variable	
LnGDPPC	Log of Gross Domestic Product Per Capita	World Bank	Dependent variable	
lnICHIV	Log of incidence of HIV all (per 1000 of uninfected population)	World Bank	Independent variable	-
PG	Annual Population Growth	World Bank	Independent variable	+
FDI	Foreign Direct Investments Inflows (% Of GDP)	World Bank	Independent variable	+
INF	Inflation, Consumer Prices (annual %)	World Bank	Independent variable	-

Source: Researcher's Construct

4. Estimation Technique

The main objective of this study is to determine the impact of population growth and HIV incidence on GDP and per capita GDP in both the short and long run. Based on the recommendation of the Hausman test, the study employs the panel model of Pooled Mean Group (PMG) estimator. This model captures both the short and long-run impacts of the target variables on GDP and Per capita GDP in Africa. Pesaran and Smith (1995), clearly demonstrate that panel data faces the problem of aggregation where the coeficient are biased especially when the slope coefficients are allowed to vary across varying cross sections. We adopted the "Pooled Mean Group", to ensure that such a problem is avoided.

This model makes the following assumptions; (1) the existence of cointegration relationship between the dependent and the independent variables require; (2) no serial correlation resulting from the residuals in the error correction model; (3) the number of years (T) should be above the number of cross sections (N). This method has the following advantages; firstly, we can run regression even if some variables are integrated of order I (0) and I (1); Secondly, the model handles issues of endogeneity; and lastly the model also considers heterogeneity and allows for variations in short and long run dynamics.

The generic specification of the panel ARDL model is given in model 1.

$$\Delta y_{it} = \varphi_i[y_{it-1} - \delta_i' X_{it}] + \sum_{j=1}^{p-1} \varphi_{i,j}\, \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \beta_{i,j}'\, \Delta X_{i,t-j} + \theta_i + \mu_{i,t} \quad \ldots\ldots\ldots \quad (1)$$

Where y_{it} is the dependent variable for country i at time t, X_{it} is the vector of independent variables for country i at time t.

We first specifiy the impact population growth and HIV incidence on GDP.

$$\Delta lnGDP_{it} = \varphi_i[lnGDP_{it-1} - \delta_i' PG_{it}] + \sum_{j=1}^{p-1} \varphi_{i,j}\, \Delta lnGDP_{i,t-j} + \sum_{j=0}^{q-1} \beta_{i,j}'\, \Delta PG_{i,t-j} + \varphi_i[lnGDP_{it-1} - \delta_i' lnICHIV_{it}] +$$

$$\sum_{j=1}^{p-1} \varphi_{i,j}\, \Delta lnGDP_{i,t-j} + \sum_{j=0}^{q-1} \alpha_{i,j}'\, \Delta lnICHIV_{i,t-j} + \varphi_i[lnGDP_{it-1} - \delta_i' FDI_{it}] + \sum_{j=1}^{p-1} \phi_{i,j}\, \Delta lnGDP_{i,t-j} + \sum_{j=0}^{q-1} \beta_{i,j}'\, \Delta FDI_{i,t-j} +$$

$$\varphi_i[lnGDP_{it-1} - \delta_i' INF_{it}] + \sum_{j=1}^{p-1} \varphi_{i,j}\, \Delta lnGDP_{i,t-j} + \sum_{j=0}^{q-1} \beta_{i,j}'\, \Delta INF_{i,t-j} + \theta_i + \mu_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Second, we specifiy the impact population growth and HIV incidence on per capita GDP.

$$\Delta lnGDPCC_{it} = \varphi_i[lnGDP_{it-1} - \delta_i' PG_{it}] + \sum_{j=1}^{p-1} \varphi_{i,j}\, \Delta lnGDPCC_{i,t-j} + \sum_{j=0}^{q-1} \beta_{i,j}'\, \Delta PG_{i,t-j} + \varphi_i[lnGDPCC_{it-1} - \delta_i' lnICHIV_{it}] + \sum_{j=1}^{p-1} \varphi_{i,j}\, \Delta lnGDPCC_{i,t-j} + \sum_{j=0}^{q-1} \alpha_{i,j}'\, \Delta lnICHIV_{i,t-j} + \varphi_i[lnGDPCC_{it-1} - \delta_i' FDI_{it}] + \sum_{j=1}^{p-1} \phi_{i,j}\, \Delta lnGDPCC_{i,t-j} + \sum_{j=0}^{q-1} \beta_{i,j}'\, \Delta FDI_{i,t-j} + \varphi_i[lnGDPCC_{it-1} - \delta_i' INF_{it}] + \sum_{j=1}^{p-1} \varphi_{i,j}\, \Delta lnGDPCC_{i,t-j} + \sum_{j=0}^{q-1} \beta_{i,j}'\, \Delta INF_{i,t-j} + \theta_i + \mu_{i,t} \quad (3)$$

Where lnGDP = Log of Gross Domestic Product, lnGDPCC = Log of Gross Domestic Product Per Capital, lnICHIV= log of incidence of HIV, PG= Population Growth, FDI= Foreign Direct Investemnts and INF= Inflation

5. Empirical Results

In this section we bring out the findings. First, we show Matrix correlations for Multicolinearity and the VIF, Second, we display the Im-Pesaran-Shin for unit root of all the variables, third, we reveal the Hausman test and finally display the Pooled Mean Group estimation results.

5.1. The Matrix Correlations

The study employs the matrix correlation to test for correlation among the independent variables as shown in table 2 and 3. We observe that all the elements of the correlation matrix show that there is no problem of multicollinearity since all corresponding elements of the matrix are less than 0.8, except for the log of HIV prevalence. The solution here is to drop the variable HIV prevelance from both models.

Table 2. Results of Correlation Matrix for Model 1.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) LNGDP	1.000					
(2) LNICHIV	-0.126	1.000				
(3) LNPHIV	-0.066	0.928	1.000			
(4) PG	-0.340	-0.017	-0.041	1.000		
(5) FDI	0.052	-0.025	-0.019	0.062	1.000	
(6) INF	-0.062	0.002	-0.040	0.056	0.049	1.000

Source: Researchers Construct in Stata 14

Table 3. Results of Correlation Matrix for Model 2.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) LNGDPPC	1.000					
(2) LNICHIV	-0.082	1.000				
(3) LNPHIV	-0.026	0.920	1.000			
(4) PG	-0.276	-0.099	-0.120	1.000		
(5) FDI	0.071	-0.038	-0.045	0.061	1.000	
(6) INF	-0.060	0.001	-0.044	0.054	0.051	1.000

Source : Researchers Construct in Stata 14

To make sure that the problem of Multicolinearity has been eliminated, the study employed the Variance Inflation Factor whose results are shown in table 4 and 5. The results back the logic of dropping down the colinear variables because the mean values of the VIF is lower than 5. In all, we conclude that there is no problem of multicollinearity among all the independent variables in both models.

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Table 4: Results of VIF for Model 1.

	VIF	1/VIF
PG	1.026	.975
INF	1.024	.977
FDI	1.008	.992
LNICHIV	1.006	.994
Mean VIF	1.021	.

Source : Researchers Construct in Stata 14

Table 5. Results of VIF for Model 2.

	VIF	1/VIF
PG	1.016	.984
LNICHIV	1.011	.989
FDI	1.007	.993
INF	1.005	.995
Mean VIF	1.01	.

5.2. Unit Root Test

In the words of Darné and Diebolt (2005), one of the problems of macroeconomic data it is non-stationary and may give misleading results. For this reason, this study used the lm-Pesaran-Shin (IPS) popularized by Pesaran et al. (1997) to test for non stationarity in the variables. The results are displayed in table 6. We observe that the variable natural log of Gross Domestic Product is not stationary at level, however it becomes stationary after the first difference. As for the rest of the variables they are stationary at level. This implies that we have a combination of I (1) and I (0) among our variables. This futher implies that the choice of our estimation technique is between Pooled Mean Group (PMG) and Mean Growth (MG).

Table 6. Results of Unit Root Tests using lm-Pesaran-Shin (IPS).

Variables	**Level**		**After first difference**	
	Constant	**Constant and trend**	**Constant**	**Constant and trend**
LnGDP	5.6378	-0.1634	-15.0576*	-11.7290*
LnGDPPC	3.3645	-0.2993	-13.4469*	-10.2227*
lnICHIV	8.0737	3.2439*	-9.4424*	-5.2551*
PG	-22.8505*	-30.1243*	-27.1617*	-30.8066 *
INF	-10.4799*	-10.2623*	-29.7471*	-27.2944*
FDI	-6.0077*	-3.5533*	-22.2119*	-19.3317*

Source : Author Calculations in STATA 14

Note : *, ** and *** denote the non existence of a unit root at 10%, 5% and 1% signifiance levels, respectively.

5.3. Hausman Test

From table 7 below, the results show results of model selection using the Hausman test. The Hausman test gives courtsey to the PMG model as opposed to the MG model since the probability value of the Chi-square statistic is insignificant even at the 1% level of significance. We therefore adopt the PMG over the MG model for estimation.

Table 7. Shows Results of The Hausman Test.

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Selecting Appropriate Model	PMG & MG	PMG & MG
	Model 1	Model 2
P value	1.00	1.00
Decision	PMG	PMG

Source: Researcher's Calculation through STATA 14

5.4. The Impact of Population Growth and HIV/AIDS on Gross Domestic Product (GDP)

The estimates of the PMG model in table 8 shows the impact of Africa's population growth and HIV incidence on GDP. In the short-run, holding other factors constant, the results show that incidence of HIV and Foreign Direct Investments are not statistically significant, implying that they have no influence on economic growth. Population growth and inflation on the other hand have a statistically significant impact on GDP. This means that holding other factors constant, on average, a one percent increase in population growth will lead to a 0.59 percent increase in GDP and vice versa. Correspondingly, on average, a one percent increase in inflation rate will lead to a 0.003 percent reduction in GDP and vice versa, assuming that all factors remain constant.

As for the long run results, we found evidence of long-run relationships among the all the variables because the coefficient of ECT (-0.054) is greater than -2. Incidence of HIV, population growth and inflation are statistically significant while foreign direct investments are statistically insignificant. This implies that, holding other factors constant, on average, a one percent increase in the incidence of HIV will lead to a 1.78 percent reduction in GDP. Likewise, on average, a one percent increase in annual population growth will lead to a 2.74 percentage increase in GDP and vice versa holding other factors constant. Similarly, a one percent increase in inflation will lead to a 0.005 percentage reduction in GDP in Africa and vice versa, on average, holding other factors constant.

Table 8. Shows PMG Results of Incidence of HIV/AIDS and Population Growth on Gross Domestic Product.

D.lngdp	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
LONG RUN						
LNICHIV	-1.780***	0.058	-30.470	0.000	-1.894	-1.665
PG	2.746***	0.230	11.960	0.000	2.296	3.195
FDI	0.021	0.019	1.100	0.270	-0.016	0.059
INF	-0.005***	0.002	-1.960	0.050	-0.009	0.000
SHORT RUN						
ECT	-0.054	0.024	-2.270	0.023	-0.100	-0.007
D1. LNICHIV	-0.060	0.094	-0.640	0.523	-0.244	0.124
D1. PG	0.593	0.274	2.160	0.430	0.056	1.131
D1. FDI	-0.003	0.004	-0.840	0.400	-0.010	0.004
D1. INF	-0.003**	0.001	-2.170	0.030	-0.006	-0.000
_CONS	0.925	0.433	2.130	0.033	0.076	1.775

Significance at 1,5 and 10 percent is denoted *** p<0.01, ** p<0.05, * p<0.1

Source : Author Calculations in STATA 14

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The PMG results for the impact of population growth and HIV/AIDS together with other control variables on per capital GDP, in the short-run, holding other factors constant, show that neither incidence of HIV, population growth nor Foreign Direct Investments are not statistically significant. This implies that they have no influence on per capita GDP in the short run. In the long run, we found evidence of long-run relationships among the all the variables as the ETC (-0.056) is greater than -2. Incidence of HIV and population growth have a significant negative long run impact on Per Capita GDP. In the long run, this implies that, holding other factors constant, a one percent increase in the incidence of HIV will lead to a 0.29 percent reduction in GDP per capita in Africa. Likewise, a one percent increase in Africa's population growth will lead to a 0.018 percentage reduction in GDP per capita in Africa and vice versa holding other factors constant. Similarly, a one percent increase in inflation will lead to a 0.005 percentage reduction in GDP in Africa and vice versa, holding other factors constant.

Table 9. Shows PMG Estimates of Incidence of HIV/AIDS and Population Growth and Per Capital Income.

D.lngdppc	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
Long Run						
LNICHIV	-0.285	0.029***	-9.740	0.000	-0.342	-0.228
FDI	0.029	0.007***	4.100	0.000	0.015	0.042
PG	-0.055	0.031*	-1.760	0.078	-0.116	0.006
INF	-0.018	0.003***	-7.310	0.000	-0.023	-0.014
Short Run						
ETC	-0.056	0.035	-6.100	0.000	-0.285	-0.146
D1. LNICHIV	-0.163	0.097*	-1.690	0.092	-0.352	0.026
D1. FDI	-0.005	0.003	-1.580	0.114	-0.012	0.001
D1. PG	0.366	0.242	1.510	0.130	-0.108	0.840
D1. INF	-0.003	0.01	3.345	1.987	1.345	.
_cons	1.556	0.254	6.120	0.000	1.058	2.055

Significance at 1,5 and 10 percent is denoted *** p<0.01, ** p<0.05, * p<0.1

Source : Author Calculations in STATA 14

6. Discussion of Findings

The results clearly show that population growth contributes positively to economic growth in Africa both the short and long run. Our findings are consistent with the results of Peter (2018), Ali et al. (2013), Furuoka, (2009) and Tartiyus et al. (1980).This is not surprising because most of these respective economies, have in the past decades invested adequately in human capital (education and training) and this has enhanced economic growth. However, there's still a long way to go as only an estimated 45% of Africans graduate from secondary school (UNDESA, 2021). Availability of knowledge does not just provide opportunities, but it also leads to innovations, creation of new knowledge and opportunities. Hence its dispersal stimulates economic growth, irrespective of the location. However, this positive contribution to growth is both a blessing and a burden. This is because on one hand, population growth provides a huge labour force and market in

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Africa but it has also added to the difficulties of employment, poverty, inequality, ending preventable and treatable diseases and conditions, and ensuring inclusive and equitable education is provided (UNDESA, 2021).

Hence, the results show that population growth has a negative significant impact on per capita GDP in the long run. This implies that if the developing countries in Africa want to increase their rate of growth of per capita GDP parallel to the developed nations, they must curb their population growth. The United Nations (2022) report therefore warns that, rapid population growth complicates the plans of developing countries to have enough funds for government spending on a per capita basis that is required to reduce poverty, end hunger and malnutrition, and ensure universal access to health care, education and other essential services.

With regards to the impact of HIV/AIDS on economic growth, the results show that the incidence of HIV has a negative impact on both GDP and per capita GDP in Africa in the long run. This is justified in the sense that, HIV/AIDS, through its effect on labour productivity and loss of earnings, affects economic growth negatively. Additionally, the associated high cost of health care implies foregoing economic growth in the resources which could have been invested productively (Were and Nafula, 2021). The AIDS epidemic moves public spending away from investments in physical and human capital to health expenditures, which slows down gross domestic product over time. Foreign and domestic private investments might also decline if potential investors become convinced that the epidemic is seriously undermining. The finding of this study are consistent with the results of Gezahegn and Upadhyay (2014), Onyeka and Diyoke, (2019), Essig and Kang, (2015), Sunday et al. (2017) and (Nketiah-Amponsah et al., 2019) who also concluded that HIV/AIDS worsens economic growth and development.

7. Conclusions and Recommendations

This study employed the Pooled Mean Group estimation technique to assess the impact of Population growth and incidence of HIV on GDP and GDP per capita for 29 selected African countries. The findings revealed that population growth affects GDP positively in Africa in the long run. On the contrary, population growth affects per capita GDP negatively in the long run. As for the incidence of HIV, it has negative consequences on both GDP and per capita GDP in the long run, however its effects in the long run is insignificant. Based on these findings, we propose the following recommendations for a better policy perspective in Africa toward achieving sustainable economic growth and development.

First, African policymakers need to increase expenditure on education and health to strengthen the development of human capital in the African economy. This policy measure has the potential to lead to more sustainable growth and a developed Africa. The logic here is that improved human capital in africa will enhance economic growth and economic development.

Second, this paper calls for more education facilities that teach science, mathematics, engineering and techonological development. This will lead to a more productive workforce and with no doubt enhance economic growth.

Third, this study proposes that African governments need to encourage their populations to use contraceptives and family planning. This move will reduce the negative impact on development growth resulting from the growth in population

Fourth, the study suggests that African governments need to expand their support towards social protection, health and education programs. This will lead to development of human capital and enable African governments to benefit more from the talents of its young people.

Fifth, this study calls for governments in Africa to collaboratively create independent and strong institutions that will not just indentify and encourage innovations for businesses but will also manage empowerments of funds for young people so that they can contribute to economic growth and development of the continent.

Sixth, the study recommends that African governments need to join forces in reinforcing the current commitments and measures that curb the spread of HIV/AIDS especially among the youth. This will ensure that the continent will be able to address the number of new infections which will result from population growth and is a bane to sustainable economic growth.

Seventh, we recommend that African governments should train more health workers, build more health facilities and strengthen the capacity of the existing ones so that the continent will be in a better place to address the devastating impacts of population growth on the impact of HIV/AIDS and economic growth relationship.

Last but not least, maintaining sustainable debt levels, curbing inflation, improving the business enviroment for local players, strengthening existing youth empowerment schemes and encouraging domestic investments are effective ways to promote growth and development in Africa.

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Data Availability: Data used for this study can be found online at https://data.worldbank.org/indicator (accessed on September 17, 2022).

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