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Population Dynamics and Economic Growth in Sub-Saharan Africa

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Abstract
The study examines the effect of population dynamics (mortality and fertility) on economic growth in sub-Saharan Africa from 1970 to 2005, using the five year average. The study focused on sub-Saharan Africa because the region is faced with a unique feature of high population growth and low economic growth when compared with other regions of the world. The study used the pooled OLS and the dynamic panel data analysis to estimate the variables, involving thirty-five countries in the sub-Saharan Africa. The results show that total fertility rate had a negative impact on economic growth while, life expectancy at birth had a positive influence on economic growth. The region needs to address the high population growth in order to have a sustainable economic development.

Keywords: population, mortality, life expectancy, fertility

1. Introduction

Many factors affect economic growth and researchers have tried to identify these factors. These factors include savings, capital accumulation, education and health spending, investment, technological progress, trade policies to mention a few. (Asian Development Bank 1997; Barro 1997; Ashipala, 2003). However, in recent times, economists have found out that demographic factors are also important in explaining economic growth. (Kelley and Schmidt, 1995; Bloom and Freeman, 1988; Crenshaw, Ameen and Christenson, 1997; Bloom, Canning and Malaney, 2000; and Bloom et.al, 2001). These recent findings showed that issues about population matters when it comes to economic growth and development.

Despite the fact that there have been studies on population dynamics and economic growth, there is no consensus on how population growth affects economic growth. Some researchers found out that population growth have a positive impact on economic growth. (Crenshaw et. al 1997; Bloom et. al 2000; Savas 2008). Others, however, (Bloom and Freeman 1988; Kelley and Schmidt 1995; Klasen and Lawson 2007) found out that population growth has a negative effect on economic growth. Some studies found no relationship between population growth and economic growth (Liddle 2003). While most of these studies have been carried out in the developed countries, (e.g. East Asia) there are limited studies in sub-Saharan Africa, hence this study.

The population of sub-Saharan Africa is growing rapidly compared to other regions of the world. In 2003, the population growth rate was about 2.5% in sub-Saharan Africa while in East Asia, it was 1.2% and in Europe and central Asia, it was as low as 0.1%. The fertility rate was high in sub-Saharan Africa with 5.2%, Latin America had 2.4% fertility rate and that of Europe and Central Asia was 1.6%. In fact adolescent fertility rate was very high in sub-Saharan Africa with 127 per thousand of women between the ages of 15 and 49 years while, East Asia had just 24. Shapiro and Gebreselassie (2007) stated that during the 1960s, 1970s, and 1980s, as fertility decline spread throughout much of the Third World. The sub-Saharan Africa was distinguished as the only major region in the world without any indication of onset of fertility transition. But by the early 1990s, however, it began to be apparent that change was taking place, and that fertility in at least a few sub-Saharan Africa countries was beginning to fall. For example, countries like Kenya, Ghana, Gabon, Senegal, South Africa and Cote d'Ivoire experienced a decline in fertility rate which was less than 5 but the number of these countries was insignificant when compared to more than 40 countries in the sub-Saharan Africa.

Most of the African countries continue to have high fertility and youth dependency rates which contribute to its economic stagnation. With the rapid population growth and low economic growth, sub- Saharan Africa is unlikely to catch up with the rest of the world by the year 2015 which means that sub-Saharan Africa may not be able to achieve most of the Millennium Development Goals especially in area of health and poverty reduction (Lyakurwa and Ajakaiye, 2006).

The Malthusian theory and neoclassical theory show the crucial link between fertility, mortality and economic growth. The theories opined that higher population depresses economic growth through diminishing returns. Hence, at this juncture, it is pertinent to raise the following questions; are the mortality and fertility rates contributing positively or negatively to the economic growth in sub-Saharan Africa? To what extent have these demographic variables (fertility and mortality rates) impacted on the economic growth in sub-Saharan Africa?

Moreover, limited empirical research has particularly in sub-Saharan Africa addressed the issue of fertility, mortality and economic growth with rather inconclusive evidence on the relationship among the variables. Therefore, the objective of this study is to investigate the effect of the population dynamics on economic growth in sub-Saharan Africa. However, this study only focuses on the mortality and fertility which are the natural demographic variables. This study is divided into five sections. Section one is the introduction, relevant literatures are reviewed in the second section. Section three presents the data and methodology, while in section four, results are presented and in the last section which is section five, policy implication and conclusion are drawn. Therefore, the next section is on the literature review.

2. Literature Review

The debate on the relationship between population growth and economic growth could be traced back to Malthus. Malthus who was seen as a pessimist or prophet of doom wrote in the 1790s, he asked whether "the future improvement of society" was possible in the face of ever larger populations. (Bloom et al 2001). According to Malthus, population tends to grow geometrically, while food supplies grow arithmetically. This dynamic interaction between population growth and economic growth is the main crux of the Malthusian model. In the neoclassical growth model, which is an extension of the Malthusian model, predicts that population growth brings about a reduction in the economic growth which is being referred to as capital dilution. Ehrlich and Kim (2005) used a Malthusian framework to explain the conflicting historical evidence on the relationship between population and economic growth since Malthus days'. The study affirms the Malthusian theory in the pre-industrial revolution but that the theory did not work after takeoff (post-industrial era).

The theory of demographic transition is based on the actual population trends of the advanced countries of the world (Jhingan, 1997). The demographic transition attempts to explain why all contemporary developed nations have more or less passed through the same three stages of modern population history. Stage one is the period of high death rate and high birth rate. The second stage is marked with low death rate and high birth rate. There is reduction in the rate of deaths because of the improved technology in health but the low death rate has not influenced the fertility level. The third stage is where both the death and birth rates are low. This is the stage of full demographic transition and the level of high modernization. Most of the developed countries are at this stage of demographic transition. However, one of the criticisms of the demographic transition theory is that it is not applicable to the less developed countries. For example, the Demographic Transition model has been validated primarily in Europe, Japan and North America where demographic data have been available over the years, whereas high quality demographic data are not available for most LDCs until recently.

Models in the tradition of Becker and Barro (1988) endogenize fertility for instance, Tamura (2006), Kalemli-Ozcan (2003), Lucas (2000) among others show that fertility may respond to reinforce this latter effect towards higher investment and growth. Hence, declines in mortality could lead to a quantity-quality trade-off where parents have fewer children but invest more in each child. Perez-Brignoli (2001) found a negative relationship between demographic variables and per capita income but they were not significant indicating a weak relationship between fertility, mortality change and per capita income. Similarly, Klasen and Lawson (2007), investigated the link between population and per capita economic growth and poverty in Uganda from 1960 to 2000. They found out that there was a negative impact of population growth on economic growth in Uganda. One of the limitations of this paper was that it failed to examine the independent impact of birth rate and death rate on economic growth.

Age structure as a measure of population dynamics was not used by this study due to non-availability of adequate data in sub-Saharan Africa. However, fertility and mortality rates were used to measure the population dynamics. Nevertheless, some studies in other regions of the world used the age structure to measure population dynamics. For instance, An and Jeon (2006) found that the age structure in Korea has improved the economic performance in that country. Likewise, Bloom et al (2006) investigate the effect of mortality, fertility and age structure on the per capita income in China and India. They found a positive effect of life expectancy on economic growth and fertility decline would improve economic growth especially in India. However, their study failed to find a positive effect of education on economic growth. Liddle (2003) also used age-specific growth rate as a measure of population growth. Using OLS regressions, he found that demographic change had no impact on economic growth stability in Latin America and Caribbean countries. Most of the studies reviewed are from developed countries but few studies exist in developing countries and in particular, sub-Saharan Africa. Therefore, this study further extends the existing literature in the area of population and economic growth in sub-Saharan Africa.

3. The Model

The neoclassical theory provides the theoretical framework of this study. The neoclassical theory suggests that growth in per capita income can be achieved either by increased savings or reduced rates of population growth. It

states that if the population grows more slowly, less saving and investment will be required for capital widening, more will be available for capital deepening (Grabowski and Shields, 1996).
The neo-classical model offers a comprehensive and rigorous treatment of population and income variables. (Currais, 2000). Therefore, starting from the Cobb Douglas production function in order to explore the relationship between demographic and economic variables we have;

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \qquad 0<\alpha<1 \qquad (1)$$

The assumptions of the Neo classical model and Solow model are employed. Like the work of Kelley and Schmidt (1995), the analysis of this study is in the tradition of the convergence literature. The model started with a demographic rendering of the convergence-patterns model and added other growth–determining variables. The model takes the form;

$$\dot{y}_t = d - \beta \ln y_{t-1} + \phi \ln X_t + \varphi \ln Z_t + \rho \ln D_t + \varepsilon_t \qquad (2)$$

X stands for both the physical capital and the human capital
Z variables represent factors influencing the economic environment as well as changes in the stocks for example, political stability, wars and violence investment returns e.t.c. These provide additional information on output growth.
D stands for the demographic variables. Demographic change in turn can influence the output growth. Certain aspects of population growth directly affect the size of the labour force, while the associated dependency of youths and the aged may deter saving and investment. (Kelley and Schmidt,1995). Therefore, D represents the population growth (n).
In order to have the panel data model, we re-write equation 2 to have;

$$\dot{y}_{it} = \alpha_i + \beta_i + \lambda \ln y_{it-1} + \phi \ln X_{it} + \varphi \ln Z_{it} + \rho \ln D_{it} + \varepsilon_{it} \qquad (3)$$

From equation 3, α_i provides for individual terms for each country and β_i provides for each time period.
Where, $\dot{y}_{it}$ is the dependent variable and is the output per capita growth; it will be proxied by GDP per capita growth.
y_{it-1} is the lagged value of income per capita, it will be proxied by lagged value of GDP per capita, its coefficient is expected to be negative.
X is the vector of physical and human capital.
Human capital is the educational attainment, for this study, it was measured by primary school enrollment, and the coefficient is expected to be positive.
Physical capital is cumulative investment overtime. It was measured by gross capital formation as a percentage of GDP; its coefficient is expected to be positive.
Z is the environmental factor measured by civil and ethnic wars and violence. The coefficient is expected to be negative.
D is the demographic variable, proxied by mortality and fertility
Mortality was measured by the life expectancy at birth; the coefficient is expected to be positive.
Fertility was measured by total fertility rate; the coefficient is expected to be negative.
ε is the error term
Each variable is computed over an average period of five years. For instance, the dependent variable $\dot{y}_{it}$ denotes the average growth rates of five years in country i.

4. Data and Estimation Technique

Data on GDP per capita growth were obtained from Penn World Tables, while data on life expectancy and total fertility rate were from World Development Indicators. Data on civil and ethnic war were got from the Polity IV database. Thirty-five countries were selected based on availability of data. However, the study still made use of an unbalanced panel data. These countries reflect the diversities that exist in sub-Saharan Africa. The countries cut across all sub-regions in sub-Saharan Africa namely; West Africa, East Africa and Southern Africa. The countries are; Angola, Benin, Botswana, Burkina Faso, Burundi , Cameroon, Central Africa Republic, Chad, Comoros, Republic of Congo, Democratic Republic of Congo, Cote d'ivoire, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Uganda, Zambia, Zimbabwe.

Pooled OLS was used to estimate the equations. However, the OLS estimations may suffer from an omitted variable bias. Therefore, in order to avoid such problem, a dynamic panel data model is also used. The use of panel data framework addresses the issue of omitted variable and bias problems encountered in single cross section analysis, because panel data model will be able to account for unobserved country specific effects,

make use of all available information (data) that is, by not reducing the time series to single (average) observation. The dynamic panel data model also allow for the endogeneity of one or more of the regressors.(Islam, 1995; Hoeffler, 2000).
The study made use of both the First-Differenced Generalized Method of Moment (DIFF-GMM) and System Generalized Method of Moment (SYS-GMM). They are suitable for large N, small T and unbalanced panel data and these apply to this study. The generalized methods of moments are also suitable for conditional convergence regressions and especially the first- differenced GMM avoids the problem raised by the omission of initial efficiency. Both DIFF-GMM and SYS-GMM make use of instrumental variables which allow parameters to be estimated consistently in models which include endogenous right-hand side variables like investment rates in the case of this study. The use of these instruments potentially allows consistent estimation even in the presence of measurement error. (Bond, Hoeffler and Temple, 2001).

In a panel data model, permanent unobserved country specific effects η_i can be explicitly accounted for. The following model is adapted from the works of Bond et. al (2001) and Hoeffler (2000). The panel data model is of the form;

$$y^*_{it} = \alpha + \lambda y_{i,t-1} + \theta m_{it} + \eta_i + v_{it} \qquad (4)$$

i = 1,……….N; t = 2,……….T

y^*_{it} is the logarithm difference in GDP per worker, $y_{i,t-1}$ is the initial level of GDP per worker and m_{it} is the vector of the explanatory variables across countries and over time.
Then we have the following dynamic panel data model.

$$y_{it} - y_{it-1} = \alpha + \lambda y_{it-1} + \theta m_{it} + \eta_i + v_{it} \qquad (5)$$

Or equivalently,

$$y_{it} = \alpha + \lambda^* y_{it-1} + \theta m_{it} + \eta_i + v_{it} \qquad (6)$$

Where $\lambda^* = (\lambda + 1)$

In order to obtain a consistent estimate of λ^* as $N \to \infty$ for fixed T, we take first differences of equation 6 which eliminates the country specific effects η_i (Hansen, 1982).

$$(y_{it} - y_{it-1}) = \lambda^*(y_{it-1} - y_{it-2}) + \theta(m_{it} - m_{it-1}) + (v_{it} - v_{it-1}) \qquad (7)$$

Or

$$\Delta y_{it} = \lambda^* \Delta y_{it-1} + \theta \Delta m_{it} + \Delta v_{it} \qquad (8)$$

In order to produce a consistent estimate of λ^*, valid instruments have to be found for Δy_{it-1}. We assume that the errors are independent across countries and serially uncorrelated

$E(v_{it} v_{is}) = 0$ for $s \neq t$

And that the initial conditions satisfy

$E(y_{it} v_{it}) = 0$ for $t \geq 2$

Then the values of y_{it} lagged two periods or more are valid instruments in the first differenced growth equation, since y_{it-2} and earlier values are generally correlated with Δy_{it-1} but not with Δv_{it}. However, m_{it} are not strictly exogenous and hence there may be a feedback mechanism where past shocks to GDP are correlated with for instance, current investment. Assuming that current shocks to GDP are uncorrelated with current investment, it implies that,

$E(m_{it} v_{is}) \neq 0$ for $s < t$

and

$E(m_{it} v_{is}) = 0$ for $s \geq t$

Then values of the predetermined m_{it} lagged one period or more as valid instruments in the first differenced growth equation. Investment, fertility and life expectancy are treated as endogenous variables. This means that we are allowing for correlation between current investment, fertility and life expectancy and current shocks to GDP, as well as feedback from past shocks to GDP.
It means that

$E(m_{it} v_{is}) \neq 0$ for $s \leq t$

and

$E(m_{it} v_{is}) = 0$ for s > t only

For this study, valid instruments in the differenced equations are values of the endogenous m_{it} lagged two periods or more.

However, Blundell and Bond (1998) show estimators relying on lagged levels as instruments for current differences are likely to perform poorly when the series are close to a random walk. They state further that the GMM estimator may suffer from serious finite sample bias and imprecision. Therefore, they suggest a system combining two sets of equations. The first set of equations are the differenced equation (equation 7), in which lagged levels of y_{it} and m_{it} are used as instruments. The second set of equations in the system is the levels equations in equation (6).

Following Arellano and Bover (1995), Blundell and Bond (1998), Hoeffler(2001) and Olomola (2007). The study adapts the estimator that combines in a system the regression in difference (equation 7) with the regressions in levels, (equation 6) to reduce regression problems as stated above. As stated earlier, for this study, investment, fertility and life expectancy are assumed endogenous, they are lagged two periods or more and used as instruments in the first-differenced equation while in level equation Δy_{it} and Δm_{it} are used as instruments. Thus additional moment conditions for the regression in levels are specified as;

$$E(\Delta m_{it} \eta_i) = 0$$

$$E(\Delta y_{i2} \eta_i) = 0$$

The consistency of the GMM estimator depends on the validity of the assumption that the error terms do not exhibit serial correlation and on the validity of the instruments. The validity of the instruments is tested using the standard sargan tests of overidentifying restrictions or using difference sargan tests comparing first differenced GMM and system GMM results. (Arellano and Bond, 1991).

5. Results

To start with, the summary statistics of the variables are presented in table 1

Table 1: Summary Statistics

	Mean for Sub-Saharan Africa	**Mean for West Africa**	**Mean for East and Central Africa**	**Mean for Southern Africa**
Real GDP per capita (US $)	1640.1	1487.3	1036.2	2583
Real GDP per capita Growth	0.005	-0.011	-0.011	0.05
Population growth	2.5	2.7	2.6	2.2
Investment-GDP ratio	18.70	18.79	15.01	22.66
Primary school enrolment rate	31.76	29.49	29.15	38.67
Life expectancy	47.98	46.68	47.19	51.15
Total Fertility rate	5.5	5.9	5.7	4.4

Source: Author's Computation

From the table 1, the mean of real GDP per capita in US dollars was about 1640.1. This was low compared to Southern Africa and other regions in the world. The real GDP per capita growth was about 0.005. However, in general, there was low growth performance in sub-Saharan Africa. The average population growth was about 2.5; this is very high compared to other regions of the world. Low per capita income growth can be explained from the high population growth rate that was being experienced in the region. This conformed to the assertion by the Malthusian theory that high population growth reduced productivity and workers' welfare. (Bloom et al, 2001).

The investment to GDP ratio was about 18.70. This means that there was low average investment to GDP in sub-Saharan African countries. This could be accounted for by the high population growth being experienced in the region. Olomola, (2007), stated that high population growth rate, increasing population pressure could limit savings and hence investment spending for productive activities. The average primary school enrolment rate was about 31.76% for sub-Saharan Africa. This rate is low because investment in human capital is low. Hence, this had accounted for the low literacy level that was witnessed in the region. The average life expectancy at birth in sub-Saharan Africa was about 47.98. The average life expectancy in the region was very low when compared to other regions in the world. This is not surprising since the region had the highest prevalent rate of communicable diseases like HIV/AIDS, tuberculosis and some other diseases. These diseases were killing mostly children and the youth. (Mboup et al, 2006).

The average total fertility rate in sub-Saharan Africa was very high with about 5.5. This region had witnessed high fertility rate over the years. This could be explained by the fact that the use of contraceptives was still very low among women in their reproductive years and sub-Saharan Africa as a region placed so much value on having children which was explained by the Old-age hypothesis and the Caldwell fertility theory. That is, children were seen as a form of social and economic security to their parents in the old age. Hence, the parents tended to give birth to many children in order to ensure these securities in their old age. (Mturi and Hinde, 2001; Ringheim and Gribble, 2010). This was why the fertility rate had been rigid downward.

5.1 The Pooled OLS

Table 2 shows the pooled OLS regression result. The regression was done in a step-wise manner to reflect the variations of the explanatory variables with the dependent variable. Therefore, ten step-wise regressions were presented in ten columns, in Table 2. The regression started with the original Solow model and the subsequent regressions were the augmented Solow model whereby proxy for investment in human capital were incorporated into the regression and later on the demographic variables were also added into the model.

In Table 2, the Wald joint tests for all the regressions were significant. The wald test was a way of testing the significance of particular explanatory variables in a statistical model. It could be used to test the true value of the parameter based on the sample estimate. Since the wald joint tests were significant, it implied that the parameters associated with the explanatory variables were not zero and that the explanatory variables could be included into the model.

In all the columns, the t-statistics were presented in parentheses for the explanatory variables. The standard errors were robust which means that the study assumed homoskedastic disturbances. Homoskedastic disturbances mean that there were similar variances across time and individuals. This may be a restrictive assumption for panel data because cross-sectional units may be of varying size and as a result may exhibit different variation.

Table 2: Step-wise Regressions Using OLS Pooled Regression

	1	2	3	4	5	6	7	8	9	10
Constant	1.85 (3.21)	1.99 (3.35)	1.99 (3.19)	-2.71 (-2.11)	5.96 (6.60)	-2.90 (-2.23)	2.93 (1.80)	-2.81 (-2.23)	5.75 (6.73)	2.20 (1.38)
Lnyt-1	-0.32 (-3.59)	-0.36 (-3.85)	-0.36 (-3.87)	-0.34 (-3.92)	-0.54 (-6.11)	-0.34 (-4.07)	-0.54 (-6.91)	-0.39 (-4.72)	-0.55 (-6.77)	-0.55 (-7.05)
Ln gcf	0.20 (1.96)	0.19 (1.93)	0.19 (1.90)	0.11 (1.14)	0.05 (0.52)	0.12 (1.29)	0.04 (0.36)	0.10 (1.16)	0.07 (0.66)	0.03 (0.75)
Lnpg	-0.19 (-1.64)	-0.14 (-1.27)	-0.14 (-1.24)							
Lnlife				1.24 (3.18)		1.28 (3.34)	0.72 (2.12)	1.33 (3.80)		0.83 (2.54)
Lnfert					-1.31 (-5.88)		-1.14 (-5.34)		-1.21 (-6.51)	-0.99 (-5.01)
Lnpenro		0.07 (5.49)	0.07 (5.53)					0.08 (6.23)	0.05 (4.80)	0.06 (5.55)
Civtot			0.002 (0.01)			0.020 (0.65)	0.02 (0.66)	0.02 (0.72)	0.02 (0.47)	0.02 (0.70)
R2	0.17	0.22	0.22	0.23	0.32	0.33	0.35	0.30	0.36	0.39
Wald Joint	13.40 (0.000)	34.14 (0.000)	36.85 (0.000)	16.88 (0.001)	40.98 (0.000)	19.65 (0.001)	83.06 (0.000)	63.44 (0.000)	66.73 (0.000)	90.62 (0.000)
AR(1)	1.97 (0.048)	2.14 (0.028)	2.20 (0.028)	2.28 (0.023)	3.28 (0.001)	2.30 (0.022)	3.35 (0.001)	2.25 (0.025)	3.37 (0.001)	3.32 (0.001)
AR(2)	2.54 (0.011)	2.59 (0.010)	2.53 (0.011)	2.78 (0.006)	3.12 (0.002)	2.60 (0.009)	3.17 (0.002)	2.44 (0.015)	2.92 (0.004)	3.03 (0.002)

Source: Author's Compilation

Note that the t values are in parenthesis for the variables while p values are in parentheses for Wald Joint, AR(1) and AR(2).

However, for this regression analysis, robust standard errors were computed in order to correct for the possible presence of heteroskedasticity. (Baltagi, 2005). This had really improved the robustness of the result in ensuring efficient estimates.
The AR(1) was presented for the step-wise regressions. This was the autoregressive process of order one. For all the regressions, the null hypothesis of no first-order serial correlation was rejected. The AR(2) was the autoregressive process of order two. For all the regressions in the columns, the null hypothesis of no second-order serial correlation was also rejected. As a result of possible biasedness of the estimates, the study made use of the dynamic panel data model, namely; Differenced Generalized Method of Moment (Diff GMM) and System Generalized Method of Moment (Sys-GMM). The results were presented in Table 3 with the aim of comparing the estimates with that of the pooled OLS.
Table 3: Mortality, Fertility and Growth (OLS, DIFF-GMM AND SYS-GMM)

	POOLED OLS (1)	DIFF-GMM (2)	SYS-GMM (3)
Constant	2.20 (1.38)	1.45 (1.37)	2.32 (1.36)
$\ln y_{t-1}$	-0.55 (-7.05)	-0.66 (-12.8)	-0.61 (-7.64)
Lngcf	0.03 (0.75)	0.13 (1.77)	0.12 (1.25)
Lnlife	0.83 (2.54)	0.35 (1.87)	0.23 (0.51)
Lnfert	-0.99 (-5.01)	-0.37 (-2.01)	-0.41 (-1.23)
Lnpenro	0.06 (5.55)	0.02 (2.80)	0.017 (2.91)
Civtot	0.02 (0.70)	0.005 (0.20)	-0.005 (-0.13)
R^2	0.39		
Wald Joint	90.62 (0.000)	572.7 (0.000)	
AR(1)	3.32 (0.001)	-2.660 (0.008)	322.7 (0.000)
AR(2)	3.03 (0.002)	-1.086 (0.277)	-1.144 (0.253)
Sargan Test		130.6 (0.011)	27.26 (1.000)

Source: Author's Computation. Note that the t values are in parentheses for the variables while p values are in parentheses for Wald joint, AR(1),AR(2) and Sargan Test.
From Table 3, the Wald joint tests for the regressions were significant. This showed that the explanatory variables can be included into the model. In all the columns, the t statistics for the explanatory variables are presented in parentheses. The study assumed homoskedastic disturbances because robust standard errors were used. Column 1 presented the results for the pooled OLS; column 2 presented the results for the Diff-GMM while column 3 presented the results for the Sys-GMM.
For the pooled OLS in column1, the null hypothesis of no first-order and second-order serial correlation was rejected. For the Diff-GMM and Sys-GMM, the null hypothesis of no first-order (AR(1)) serial correlation was rejected . However, we failed to reject the null hypothesis of second-order (AR(2))serial correlation. First differencing introduced AR(1) serial correlation when the time varying component of the error term in levels was serially uncorrelated. Therefore, GMM estimates were consistent only when second-order correlation was not significant. (Olomola, 2007). The Sargan test for the Diff-GMM was significant while the one for the Sys-GMM was not significant. The Sargan test identified the restrictions under the null hypothesis of the validity of the instruments. Hence, the instruments were valid for the Diff-GMM because the coefficient was significant with $p < 0.05$, but were not valid for the Sys-GMM.
5.3 Discussion of Findings
The theoretical framework for this study was based on the neoclassical growth theory, starting from the basic Solow model. In Table 2, column 1, the OLS regression result indicated that the sub-Saharan African countries followed the predictions of the Solow model which is similar to the findings of Hoeffler (2000). The population growth was calculated following the works of Islam 1995 and Mankiw, Romer and Weil (1992). The coefficient of population growth (lnpg) was negative. This followed the predictions of the "pessimist". The

Malthusian theory is a major pessimist theory in population. Malthus had raised an argument that population growth caused by high fertility eroded the welfare and productivity of workers.

According to Bloom et.al (2001), higher population numbers required more homes, factories and infrastructure, to house, employ and provide for their needs. In the long run such capital could be constructed, but periods of rapid population growth might well lead to reductions in capital per worker and lower living standards. When population growth was rapid, a large part of investment was used to supply the needs of the growing population rather than enabling an increase in the level of provision per capita. Therefore, at the macro level, high population growth rate could deter growth especially in sub-Saharan Africa. This result also supported the result of a study on population and economic growth in Uganda. Klasen and Lawson (2007) also found out that population growth impacted negatively on economic growth in Uganda.

The coefficients on primary school enrolment were positive and significant. This implied that increase in primary school enrolment in sub-Saharan Africa would improve economic growth. Perez-Brignoli (2001) also found a positive impact of primary school enrolment on economic growth in Costa-Rica. However, contrary to the apriori expectation, the coefficient on ethnic and civil war was positive but not significant. Nonetheless, Becker, Murphy and Tamura (1994), were of the view that during wartime destruction of physical capital in a country could stimulate rapid investment in the physical capital. Eventually, it might stimulate more rapid investment in human capital. Therefore, in the long run the per capita income would exceed what would have been if the war had not happened. Life expectancy had a positive effect on economic growth. A study by Bloom, Canning and Jamison (2004), also found a positive effect of life expectancy on economic growth. In table 1, columns 5,7,9 and 10 revealed that the fertility rate had a negative effect on economic growth. Table 2, showing the Diff-GMM and the Sys-GMM also revealed similar result between fertility and economic growth in sub-Saharan Africa. These results supported the pessimistic view that high fertility reduces income. The inverse relationship between fertility and economic growth implied that when the number of children per family was large, per child parental nurturing was low, diluting the transmission of human capital and slowing output growth (Micevska, 2001).

6. Conclusion

The study examined the effect of population dynamics (mortality and fertility) on economic growth in 35 countries in sub-Saharan Africa. From 1970-2005, using a five year average. The study revealed that life expectancy contributed positively to economic growth while fertility contributed to economic growth negatively in sub-Saharan Africa.

Some policy implications could be drawn from this study. High fertility rate put pressure on the physical and social infrastructures. There would be increased demand for education, better health services, housing and services for an ever-growing population which most of the countries in sub-Saharan Africa cannot meet because of low per capita income. The positive relationship between life expectancy and economic growth implied that high mortality rate hampered growth in sub-Saharan Africa. There have been economic losses due to HIV/AIDs, malaria and other diseases. This has made economic advancement in the region difficult because those affected with these diseases spend most of their productive time in the hospitals thereby reducing working hours which could eventually reduce productivity.

Conclusively, if the region wants to develop quickly, like other regions in the world, there is the need to act on measures that will reduce both mortality (both child and adult) and fertility. These measures could be through implementing an effective family planning programmes across the countries in sub-Saharan Africa. "Education for all" policy should be formulated and implemented. Also, primary health care services should be provided in all the rural areas and the urban centres in sub-Saharan Africa.

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