# Population and Economic Growth in Tanzania

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**Abstract**

The debate on the relationship between population growth and economic growth has been enduring and varies across countries. While the first theory on population and economic growth states that population growth stimulates economic growth, the second theory views population growth as a factor that adversely affects economic growth. The third school of thought posits that population growth is a neutral factor in economic growth, and is determined outside standard growth models. Given this situation, there was a need to establish the relationship between economic growth and population growth in Tanzania. The study employed the Vector Auto-regression (VAR) estimation technique, and used annual time series data from 1971 to 2017. The results indicate that economic shocks due to population growth are positive and negative. This could be attributed to unstable expenditure on healthcare by the government in the improvement of child survival through various government programmes. The study concludes that, in Tanzania, population growth promotes economic growth and, subsequently, economic development. The study recommends that the government should ensure that the economy grows at a higher rate than population growth. This will ensure that the increasing demand for services arising from population growth is met. Having a large, healthier, and better-educated workforce will only bear economic fruit if the extra workers can find jobs.

**Keywords:** *population growth, economic growth, VAR*

## Introduction

High population growth is a growing concern throughout the world and a challenge to any country's economy. The world's population was about a billion in 1800, and rose to 2.5 billion in 1950 (Martin, 2009). In 2007, the world's population was 6.7 billion; and is projected to grow to 9.2 billion by 2050, with almost all population growth projected to occur in what is now considered less developed regions. Between 1950 and 2000, when the world's population increased from 2.5 billion to 6.1 billion, significant shifts in population weights by continent were the result of changes in fertility and mortality rather than large-scale migration (Martin, 2009).

Economists are uncertain between two theories: the one stating that population growth helps a nation's economy by stimulating economic growth and development; and the other basing its theory on Robert Malthus' (1798)

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findings: that population increase is detrimental to a nation's economy due to various problems caused by a population growth. Malthus and Johnson (ibid.) pointed out that population tends to grow geometrically, whereas food supplies grow only arithmetically. According to the Malthusian model, causation goes in both directions. Higher economic growth increases the population by stimulating early marriages, high birth rates, and reducing mortality rates from malnutrition. Bloom and Freeman (1988) differ with the theory of Malthus, noting that the food problem is more of an issue of poverty and inadequate income than a matter of high population growth.

According to Martin (2009), rapid population growth tends to depress savings per capita, and retards the growth of physical capital per worker. The need for social infrastructure is also broadened, and public expenditures must be absorbed in providing the need for a larger population rather than in providing productive assets directly. Population pressure is likely to intensify the foreign exchange constraints by placing more pressure on the balance of payments. The need to import food will require the development of new industries for export expansion and import substitution.

More people may mean a country can produce and consume more goods and services, leading to economic growth. Nevertheless, this can only occur when employment opportunities grow at least as fast as the labour force, and when people have access to the necessary education and training. If human capital per capita were sufficiently large, the economy would move to steady-state growth, whereby consumption per capita would increase at a slower rate than human capital if the population is growing and if the production of consumer goods in the steady-state growth path has diminishing returns to population. However, consumption per capita can still be increasing, despite these diminishing returns, if the positive impact of the growth in human capital on productivity in the consumption sector more than offsets the negative effect of population growth. Thus, zero population growth is not necessary for sustainable growth in per capita consumption, even with diminishing returns to the population in the production of consumer goods (Meier & Rauch, 1995).

Economists advocating the positive side to population growth argue that population growth creates problems in the short-run; including poverty, famine, and unemployment. Yet, they admit that in the long-run it leads to new developments through advancement in technology that leaves countries better-off than if the problems never occurred. On the positive side, there is a chain reaction of events caused by population growth. According to the neoclassical growth model, population growth is beneficial to an economy since population growth is correlated to technological advancement. An increase in labour availability and a low cost for labour results in a huge rise in employment as businesses are more inclined to cheap labour. Low labour costs result in a shift of money usage from wages into advancement through technology (Coale & Hoover, 1958).

Figure 1 presents the trend in population growth and gross domestic product (GDP) in Tanzania from 1971 to 2017. The figure shows that the trend in population growth in Tanzania has been fluctuating over the years. It shows that the country recorded the highest population growth in 1992 at 3.38%. In 1999, the growth rate increased to 2.56% from 2.55% in 1998. The population growth rate decreased between 1992 and 2005, recording a growth rate of 2.99%. Between 2006 and 2017 growth rate fluctuated around 3% (URT, 2019). During the same period, the rate of growth of GDP was cyclical. As can be observed from Figure 1, the GDP growth rate has also fluctuated over the years. In 1977, the growth rate declined to only 0.40% from 6.39% in 1976. GDP growth improved in the year 1978, recording a growth rate of 1.21%.
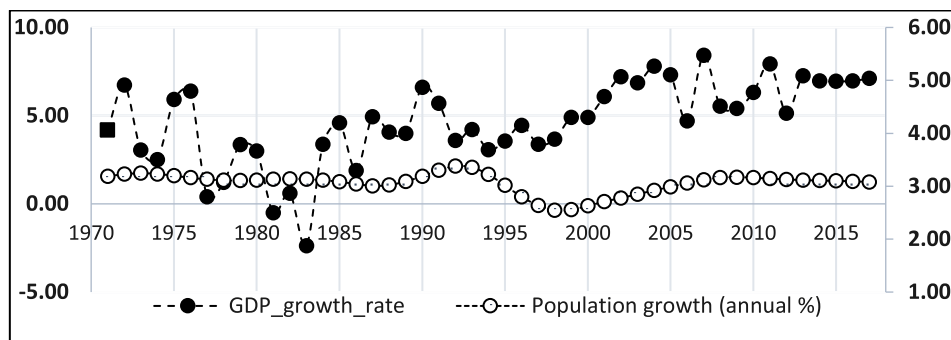


**Figure 1: Trends in GDP and Population Growth over the Period 1971-2017**
**Source**: Computed by the authors

In 1981, the economy recorded a negative growth of 0.5%, but four years later in 1985 there was a marked performance when the economy grew by 4.59%. In 1983 the worst performance of the economy was recorded at a growth rate of negative 2.38%. The shocks of the war between Uganda and Tanzania, and unfavourable climatic conditions contributed to the decline. The economy again improved in the following years, but in 1986 it went down to 1.89%. There was a turnaround in the economic performance between 1995 and 2004 when economic growth increased from 3.02% in 1995 to 7.8% in 2004. The growth rate, however, declined to 4.69% in 2006. Concisely, Figure 1 shows that both GDP growth and population growth rates have no trend over time.

Fertility rate is a significant contributing factor to population growth. The total fertility rate is the average number of children born to a woman over her productive life. In Tanzania, the total fertility rate has been fluctuating over the years. The total fertility rate was 6.3 children per woman from 1991 to 1992, which decreased to 5.8 children in 1996, and declined further to 5.6 children in 1999. Between 2004 and 2005 the fertility rate was 5.7 children per woman. There was a decrease in fertility rate to 5.4 children per woman for 2010. The fertility

rate increased again to 5.5 children in 2012 (NBS, 2013). There was a disparity in infertility among rural and urban women that could be attributed to the significant role played by education in population growth.

The trend has been that when the literacy of women improves, fertility rates also tend to decrease. Contraceptive use increased from 10% of married women in 1992 to 34% in 2010 (NBS, 2013). The debate about the impact of population growth on the economy is thus still ongoing. On the positive side, population growth induces technological advancement and innovation. This is because population growth encourages competition in business activities and, as the country's population grows, the size of its potential market expands. The expansion of the market, in its turn, encourages entrepreneurs to set up new businesses (Simon, 1993).

On the other side, large population growth is not only associated with food problems but also imposes constraints on the development of savings, foreign exchange, and human resources. The increase in demand for food leads to a decrease in natural resources that are needed for a nation to survive. Other negative effects of population growth include poverty caused by low income per capita, famine, and disease since rapid population growth complicates the task of providing and maintaining infrastructure, education, and health care needed in modern economies (Barro, 1991; Mankiw et al., 1992).

Across nations, evidence on the relationship between population growth and economic growth is inconsistent as the underlying parameters and assumptions vary across countries. The existing literature also points out that, depending on the country, population growth may contribute, prevent or even have no impact on economic growth. This is explained by the fact that the effects of population growth change over time. For example, a higher fertility rate can have short-term negative impact caused by expenditures on children. In contrast, it has a long-run positive effect through the more significant labour force it generates. This study sought to answer the following questions: What is the causal relationship between population growth and economic growth? What is the response of population growth due to shocks in economic growth? What is the response of economic growth due to shocks in population growth? What are the sources of variation in economic growth?

**Literature Review**
*Theoretical Literature on Population and Economic Growth*
Boserup (1965) found out that population growth is an autonomous factor affecting agricultural productivity rather than being affected by it, as suggested by the Malthusian school. The study claimed that Malthus' assumption of diminishing returns to labour does not hold in the long-run as a bigger population may lead to a more efficient division of labour and improved agricultural practices (signalled by the frequency of cropping). The study

concluded that soil fertility should not be viewed as fixed and given by nature, but instead can be improved by substituting agricultural technology for a better one, which is likely to result from an increase in population. Primitive communities with higher population growth rates are more likely to experience economic development if the necessary investment in agriculture is undertaken.

Thirlwall (1988) investigated the relationship between population growth and economic development in developing economies. The study found out that the relationship between population growth and economic development is a complex one, particularly concerning the causes and effects. Also, it found that rapid population growth lowers per capita income growth in least developed countries (LDCs). Yet, there are many ways in which population growth may be a stimulus to progress. There are many rational reasons why families in developing countries choose to have many children. The study concluded that the complexity of the subject is compounded by the fact that economic development is a multidimensional concept. The pace of economic development depends on diverting resources from consumption to uses that raise future output. A population with a high ratio of dependents on producers consumes more of a given output and devotes less to investment. Thus, high fertility, which produces a high level of dependency, promotes consumption at the expense of investment.

Simon (1977) investigated the long-run benefits of population growth. The study found that whereas population growth has a negative effect on living standards in the short-run due to diminishing returns and the temporary burden it poses on society, it has positive effects on living standards in the long-run due to knowledge advances and economies of scale. Employing a simulation model, the study found that in the long-run (after 30 to 100 years), and when compared to a constant-size population, moderate population growth improves standards of living both in more developed and in less developed countries. In the final analysis, a growing population tends to advance knowledge, which, in turn, increases productivity and output at a higher rate than that of population growth. Nevertheless, a country's optimal policy regarding population growth depends on the weight given to the future relative to the present. The more weight a country gives to future generations, and the more willing a country is for the short-run decline in the standards of livings, the better it is for that country to pursue a policy of moderate population growth. Thus, the long-run benefits of population growth that link to the economic development of developing countries are on a positive balance, contrary to conventional wisdom.

Porter (1996) employed a Solow-Swan economic growth model with exogenous saving rates to determine the relationship between population growth and economic growth. The model assumed that both the saving rate and the consumption rate are given as long as a household owns the input and manages the technology. The production technology is adopted to take the form:

$$Y_t = F(K_t L_t \qquad (1)$$

Where $Y_t$ is the total output, $K_t$ is the total physical capital, and $L_t$ is the size of the labour input.

The production function exhibits positive and diminishing marginal products to each input and exhibits constant scale returns. The economy is assumed to be a one-sector economy, where output can be either consumed or invested; and capital depreciates at a constant positive rate *(δ)*. The growth rate of the population is exogenous. The model further assumes that this growth rate is a constant *(n)* and that labour supply per person is a given. The labour input normalizes the population size at time zero, and the work intensity to one yields the following:

$$L_t = e^{nt} \qquad (2)$$

The net increase in per capita capital is

$$k_t = sf(k_t) - (n + \delta)k_t \qquad (3)$$

The first term on the right-hand side (RHS) is saving per capita out of output per capita, and the second term is the effective depreciation per capita. Defining a steady state is a situation in which the quantities -- such as capital, population and output -- grow at constant rates. In the Solow-Swan model, a steady-state exists if the net increase in per capita capital equals zero. Denoting steady-state values with an asterisk, the steady-state values are given by:

$$sf(k^*) = (n + \delta)k^*, y^* = f(k^*) \text{ and } c^* = (1 - s)f(k^*) \qquad (4)$$

Since the per capita values are constant in a steady state, the levels of total output, total consumption, and total capital must grow at the same rate as that of the population growth *(n)*. An increase in the rate of population growth in a steady-state does not affect the growth rate of the per capita variables since these rates are equal to zero in a steady-state. However, an increase in fertility does lead to a decrease in the level of capital per capita and, therefore, to a decrease in output and consumption per capita. This is the capital dilution effect. An increase in the population growth rate leads to a decline in the growth rate of the per capita variables. For a model with exogenous saving rates, a higher population growth leads to a lower standard of living per capita, measured either as consumption or in consumption growth.

Becker et al. (1999) developed altruistic models of intergenerational transfers where the behaviour of an individuals is guided by a utility function that is increasing in the individual's consumption and the utility achieved by one's offspring. The utility of the offspring depends, in turn, on their consumption and the utility of their offspring. Through this inter-linking chain, the current generation consumes and transfers resources to its children influenced by its concern for its children and all future generations. An important implication of

this model is that familial transfers will neutralize fiscal policy. When a government exercises an expansionary fiscal policy, it stimulates the economy by increasing current spending financed by issuing debt. From the perspective of intergenerational transfers, the policy is an effort to stimulate spending by transferring resources to current generations from future generations. According to this model, however, public policy is undone by altruistic households that compensate future generations by increasing their savings and accumulating wealth, offsetting the increase in public debt. This model implies that public intergenerational transfers and private intergenerational transfers are perfect substitutes. A change in public transfers is matched dollar-for-dollar by a compensating change in private transfers.

**Empirical Literature on Population and Economic Growth Nexus**
Bloom and Freeman (1986) provided a comprehensive organizing framework for analysing the impact of population growth on labour supply and employment. In particular, they identified two distinct mechanisms through which population growth affects labour supply and employment. One is the 'accounting' aspect that refers to changes in the demographic structure and cohort size. The other is the 'behavioural' aspect that refers to the decision to participate in the labour force, particularly by women. Fertility, mortality, and migration will affect labour supply differently. Mortality and migration will have immediate effects, while fertility will have delayed effects. They also pointed out that the labour market structure mediates the impact of population growth on employment. For instance, in a neoclassical labour market, rapid population growth will instantaneously depress wages. In a dual labour market where one market (modern) is behaving like a new classical labour market; and another (traditional) is characterized by surplus labour and low wage rates, rapid population growth will delay the tightening and eventual dissolution of the low wage traditional labour market (or the elimination of the dualistic structure). In their review of labour markets in developing countries covering the period 1960-1980, they concluded that despite the rapid population increase, developing countries managed, on the whole, to improve their economic positions significantly (ibid.).

According to Kelley (1988), a slower population growth pace will help enhance economic growth at a higher rate. The study elaborated that economic growth would be higher in slower population growth even though the impact of population growth in many countries was insignificant. Population and per capita income are closely associated with depicting the picture of economic growth. Lower population growth and higher per capita income show that a nation is achieving its growth targets. In countries with population growth under 1%, their per capita income could increase at the rate of 2.5% annually. Countries with a population growth of more than 2% had a little increase in less than 2% per capita income (ibid.).

Mankiw et al. (1992) used a Cobb-Douglas economy-wide production function to investigate the impact of population growth on 'steady-state' income per capita and economic growth in the transition to a steady-state. They revealed that an increase in the population growth rate of 10% (e.g., 3% to 3.3%) would reduce per capita income in a steady-state by 5%. If, however, one considered human capital an additional factor of production (which is eminently reasonable), then the negative impact of population growth is larger as population growth now forces economies to use their scarce savings to equip young people with physical and human capital. As a result, a 1% increase in population growth would decrease per capita income by 2% (ibid.).

Bloom and Williamson (1998) also found that demographic factors are important determinants of economic growth; and that it is not the overall population growth rate that drives economic performance, but age distribution. The age distribution effect operates through the difference in growth rates of the working age and the dependent population. The study found that population dynamics explain as much as 1.4 to 1.9% points of the GDP per capita growth in East Asia; or one-third of the average East Asian miracle GDP per capita growth rate (1.9/6.1). In South-east Asia, the estimated effect ranges from 0.9 to 1.8 points of economic growth; or about half (1.8/3.8) of the recorded growth in GDP per capita (ibid.).

Bucci (2008) investigated whether there is a long-run relationship between population (size and growth) and per-capita income, focusing on human and physical capital as reproducible inputs. The study found out that population growth exerts a negative effect on economic growth. However, when individuals choose endogenously how much to save, population growth can also neutrally influence economic growth. The study also extended its analysis to the case where physical and human capital can interact with each other in the production of new human capital. When the two types of capital substitute one another in the education sector, the effect of population growth on per-capita income growth is always negative. On the other hand, if human and physical capital is complementary, the impact of population change on real per-capita income growth becomes ambiguous. The intuition is that for a given per-capita physical capital stock, an increase in population causes the aggregate physical capital to rise. If physical and human capital are substitutes for each other (in the sense that the larger amount of physical capital now available in the economy deters the demand and, thus, the consequent supply of human capital), the increase of population size, together with the reduction of the aggregate human capital stock, determine an unambiguous decline of the per-capita level of skills and, via this channel, a lower per-capita income growth rate. On the other hand, if physical and human capital are complementary for each other (the increase in the supply of physical capital spurs the demand and, therefore, the consequent production of new human capital), the final effect on the per-capita level of skills and, hence, on per-capita income growth of an

increase in population may be either positive, or negative, or else equal to zero. Long-run per-capita income growth can be positive even without any population change: in equilibrium, both the growth rate and the level of per-capita income are independent of population size. The long-run level of per-capita income is proportional to per-capita human capital.

Population growth is a crucial factor in the growth and development of any country; and with the continued divergence of opinions regarding the consequences of population growth on economic development, this study thus serves as a necessary contribution to knowledge offering information regarding the same in Tanzania. The study also serves as resource material to policy-makers and scholars by providing relevant information regarding population and economic growth. It also helps to provide useful information to private and public agencies in designing projects and programmes that can assist in bringing a balance between population growth and economic growth.

## Methodology
### *Theoretical Framework*
This article adopted the Solow-swan model of growth. The Solow's model takes the rate of saving, population growth, and technical progress as exogenous. There are two inputs -- capital and labour -- which are paid by their marginal products. Assuming a Cobb-Douglas production function, the production function at time *t* is given by:

$$Y_{(t)} = K_{(t)}^{\alpha} A_{(t)} L_{(t)}^{1-\alpha} \quad 0 < \alpha < 1 \qquad (5)$$

Where: $Y_{(t)}$ is output, $K_{(t)}$ is capital, $L_{(t)}$ is labour, and $A_{(t)}$ is the level of technology. The initial levels of capital, labour, and technology are taken as given.

Labour and level of technology grow at constant rates:

$$\dot{L}_{(t)} = nL_{(t)} \qquad (6)$$

$$\dot{A}_{(t)} = gA_{(t)} \qquad (7)$$

Where *n* and *g* are exogenous parameters, a dot over a variable denotes a derivative to time.

Applying the result that a variable growth rate equals the rate of change of its log to equations (6) and (7) tells us that the rates of change of the logs of *L* and *A* are constant and equal *n* and *g,* respectively. Thus,

$$lnL_{(t)} = lnL_{(0)} + nt \qquad (8)$$

$$lnA_{(t)} = lnA_{(0)} + gt \qquad (9)$$

Where *L* (0) and *A* (0) are the values of *L* and *A* at time 0.

Exponentiating both sides of these equations give us:

$$L_{(t)} = L_{(0)}e^{nt} \qquad (10)$$

$$A_{(t)} = A_{(0)}e^{gt} \qquad (11)$$

The number of effective units of labour, $A_{(t)}$ and $L_{(t)}$, grows at a rate of $n + g$.

The model assumes that a constant fraction of output $s$ is invested. Defining $k$ as the stock of capital per effective unit of labour, $k = K/AL$, and $y$ as the level of output per effective unit of labour, $y = Y/AL$, the evolution of $k$ is governed by:

$$\dot{k}_{(t)} = sy_{(t)} - (n + g + \delta)k_{(t)} = sk_{(t)}^{\alpha} - (n + g + \delta)k_{(t)} \qquad (12)$$

Where $\delta$ is the rate of depreciation.

Equation (12) implies that $k$ *converges* to a steady-state value defined by:

$$sk^{\alpha} = (n + g + \delta)\dot{k} \text{ or } \dot{k} = \left(\frac{s}{n + g + \delta}\right)^{1/1-\alpha} \qquad (13)$$

The steady-state capital-labour ratio is related positively to the rate of saving, and negatively to the rate of population growth. The central prediction of the Solow model concerns the impact of saving and population growth on real income. Substituting equation (13) into the production function (2.5) and taking logs, we find the steady-state income per capita is:

$$\ln\left[\frac{Y_{(t)}}{L_{(t)}}\right] = \ln A_{(0)} + gt + \frac{\alpha}{1 - \alpha}\ln(s) - \frac{\alpha}{1 - \alpha}\ln(n + g + \delta) \qquad (14)$$

Because the model assumes that factors are paid their marginal products, it predicts the signs and magnitudes of the coefficients on saving and population growth. A relating theoretical model to the study, an extract from equation (14) can be expressed as:

$$\Delta GDP_t = f(\Delta POP_t) \qquad (15)$$

Where $\Delta GDP_t$ is the economic growth rate, and $\Delta POP_t$ is the population growth rate.

### The Model

The study used time-series data, and therefore, there was a need to determine whether the variables in question were stationary or non-stationary. The Zivot-Andrew's test was used to test for stationarity of the series. When time-series data is non-stationary and used for analysis, it may give spurious results.

The other step was to test whether any of the variables in the model were weakly exogenous. A variable $x_{(t)}$ is said to be weakly exogenous for estimating a set of parameters $\lambda_{(1)}$ if the joint probability density function $f(Y_{(t)}; x_{(t)}; \lambda)$ can be partitioned as:

$$f(y_t, x_t; \lambda) = g(y_t|x_t; \lambda_1)h(x_t; \lambda_2) \qquad (16)$$

So that inference on $\lambda_1$ can be conducted with no loss of information from the conditional density function $g(y_t|x_t; \lambda_1)$ (Engle et al., 1983).

A weak exogeneity concerns the extent to which the parameters of the marginal distribution of the exogenous variable can be ignored when focusing on the conditional distribution of the endogenous variable given the exogenous variable. Should a weak exogeneity not hold, then estimation must account for both the marginal and conditional distributions. If all the variables happen to be weakly exogenous, using a system of equations and VAR approach in the study would not be justified (Oduor, 2008). Weak exogeneity tests were, therefore, necessary to detect specification errors in the model.

The empirical approach to this article was based on the VAR approach, which is a method of time series analysis that assumes structural relationships between the economic variables. The use of structural VAR was justified because of the possibility to simulate the response over time of any variable in a set to either an own disturbance or a disturbance to any other variable in a system of equations (Stock & Watson, 2001). A structural VAR was used to examine the relationship among a set of lags of economic variables and analyse the dynamic impact of random disturbances on the system of variables in this study.

A VAR econometrics analysis involves estimating regression equations in which the current value of each variable is expressed as a function of lagged values of itself and each of the selected variables. No variable is assumed to be exogenous a priori, and no variable is excluded from the autoregressive equation for any of the variables in the system. The study employed a reduced form structural VAR system to test for the impact of population growth on economic growth. The standard estimable VAR (1) model, with the variables in the relationship (17), was specified as:

$$GDP_{(t)} = \beta_{10} - \beta_{12}POP_{(t)} + \emptyset_{11}GDP_{(t-1)} + \emptyset_{12}POP_{(t-1)} + \epsilon_{1t}$$

$$POP_{(t)} = \beta_{20} - \beta_{21}GDP_{(t)} + \emptyset_{21}POP_{(t-1)} + \emptyset_{22}GDP_{(t-1)} + \epsilon_{2t} \qquad (17)$$

$$\begin{pmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{pmatrix} \sim \text{iid} \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \delta_1^2 & 0 \\ 0 & \delta_2^2 \end{pmatrix} \right\}$$

In this type of VAR model, each variable was regressed on a constant variable $C_{ij}$, $p$ lags of itself, $p$ lags of each of the other variables, and the disturbance term $\epsilon_t$. The lag length ($p$) choice was determined using the Akaike Information Criterion (AIC). The sample consists of observations from $t = 1 \ldots. 47$ in years. The exogenous error terms $\epsilon_{1t}$ and $\epsilon_{2t}$ are independent and are interpreted as structural innovations. $\epsilon_{1t}$ is interpreted as capturing unexpected shocks to GDP that is uncorrelated; $\epsilon_{2t}$ as the unexpected shocks to the population.

In equation (17), putting GDP = $y_{1t}$ and Pop = $y_{2t}$, the endogeneity of $y_{1t}$ and $y_{2t}$ is determined by the values of $\beta_{12}$ and $\beta_{21}$. In the matrix, form (17) becomes:

$$\begin{bmatrix} 1 & \beta_{12} \\ \beta_{21} & 1 \end{bmatrix}\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix} + \begin{bmatrix} \emptyset_{11} & \emptyset_{12} \\ \emptyset_{21} & \emptyset_{22} \end{bmatrix}\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} \qquad (18)$$

Or

$$BY_t = \beta_0 + \pi_1 Y_{t-1} + \epsilon_t \qquad (19)$$

*Estimation Techniques*
The coefficient estimates were used in the derivation of impulse responses and forecast error variance decomposition. Impulse response analysis links the current value of the error term to the future values of $Y_t$ or, equivalently, the current and past values of the error term to the current values of $Y_t$. An impulse response enables one to trace the effect of a one-time shock to one of the innovations on the current and future values of the endogenous variable. The impulse responses are obtained from a vector autoregression moving average (VARMA); given a general representation of a VARMA as:

$$\Delta X_t = \sum_{j=0}^{\infty} \Phi_i \varepsilon_{t-j}$$
$$i = 1,2, \dots \dots \dots \dots \dots k$$
$$j = 0,1,2, \dots \dots \dots \dots \dots \infty \qquad (20)$$

Where $\Phi_i$ is the impact multipliers denoting the response of each variable to innovations in each of the corresponding error terms on impact; $\varepsilon_{t-j}$ are innovations; and $k$ is a number of variables in the system. $\Phi_i(0)$, $\Phi_i(1)$ and $\Phi_i(k)$ are the impulse responses that will be plotted to trace the time path of the system variables as they respond to various shocks over time.

Variance decomposition separates the variations in an endogenous variable into the component shocks to the VAR. This variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR. It tells how much of a change in a variable is due to its own shock; and how much is due to shocks to other variables. In the short-run, most of the variations are due to own shocks. But as the effect of the lagged variables starts kicking in, the percentage of the effect of other shocks increases over time.

**Data Acquisition**
The GDP growth rate variable represents how Tanzania's GDP increases. This is the difference between current GDP and the previous year's GDP, and is measured in percentage. Population increase (POP) variable refers to the change in population over a unit period, or the growth in people over a given time. This study made use

of published data for the period ranging from 1971 to 2017. The primary sources of this data were the World Bank website, Tanzania National Bureau of Statistics publications, and Tanzania Economic Surveys.

## Results and Discussion

This section presents the study findings with the components of unit root test, Granger causality test, lag length selection, impulse response analysis, and variance decomposing analysis. When time-series data is non-stationary and used for research, it may give spurious results because estimates obtained from such data will possess non-constant mean and variance. Since this study used time-series data, therefore it was essential to establish the stationarity of the data.

Before carrying out the unit root test, it was important to check whether the time series had a structural break. The results show that both variables have a structural break (see Figures 2 and 3).
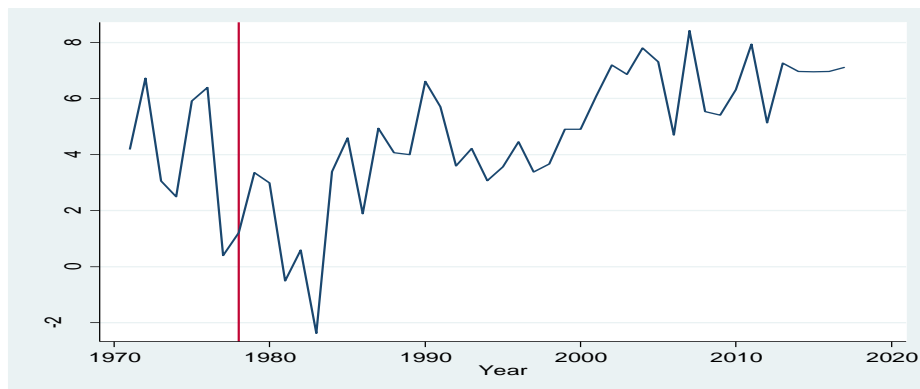


**Figure 2: GDP Growth Rate Structural Break**
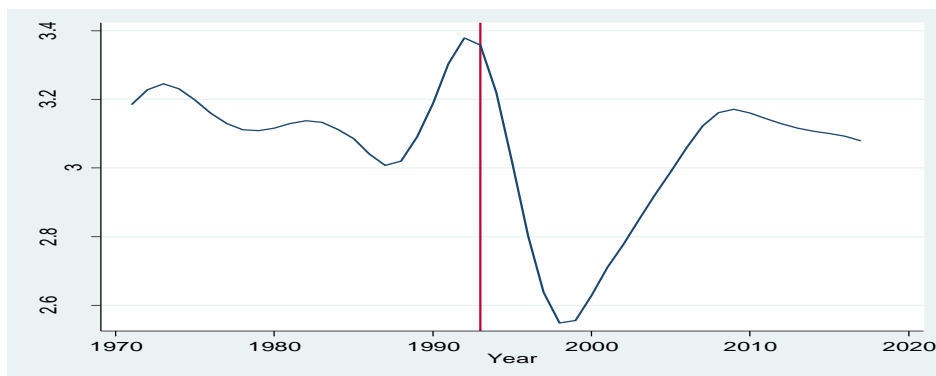**Source**: Computed by the authors



**Figure 3: Population Growth Structural Break**
Sources: Computed by the authors

In this regard, the Zivot-Andrews unit root test was used for the unit root test, taking into account structural break. Since the variables have no trend, the Zivot-Andrews unit root specification is given as:

$$\Delta y_t = c + \alpha y_{t-1} + \gamma DU_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \qquad (21)$$

Where $DU_t$ is the dummy variable for a mean shift occurring at each possible break date (T.B.).

$$DU_t = \begin{cases} 1 \text{ if } t > TB \\ 0 \text{ otherwise} \end{cases} \qquad (22)$$

The null hypothesis is $H_0 : \alpha = 0$

The unit root results of the variable in the model are reported in Table 1. Since the calculated Z-A test statistic value is greater than the critical value at a 95% confidence level for GDP growth, its GDP growth rate is stationary at the level. The population growth rate is stationary at the first difference at a 95% confidence interval.

**Table 1: Result of Zivot -Andrews Unit Root for Single Structural Break Test**

| Variable | | | t-Statistic | Critical Values | Break Year | I(d) |
|---|---|---|---|---|---|---|
| GDP Growth Rate | Levels | Intercept | -5.321 | 1%: -5.34 5%: -4.80 10%: -4.58 | 1978 | I(0) |
| Population Growth Rate | Levels | Intercept | -3.823 | 1%: -5.34 5%: -4.80 10%: -4.58 | 1993 | |
| Population Growth Rate | 1st difference | Intercept | -4.668 | 1%: -5.34 5%: -4.80 10%: -4.58 | 2002 | I(1) |

**Source**: Computed by the authors

The first objective of the study was to investigate the causal relationship between population rate and economic growth rate in Tanzania. The granger causality test was carried out to find the causation between the two variables. The results are reported in Table 2.

**Table 2: SVAR Test Results**

| VARIABLES | (1) a_1_1 | (2) a_2_1 | (3) a_1_2 | (4) a_2_2 | (5) b_1_1 | (6) b_2_1 | (7) b_1_2 | (8) b_2_2 |
|---|---|---|---|---|---|---|---|---|
| Coefficients | 1 | -0.00187 | 0 | 1 | 1.998*** | 0 | 0 | 0.0356*** |
| Standard errors | (0) | (0.00266) | (0) | (0) | (0.211) | (0) | (0) | (0.00376) |
| Observations | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |

**Notes**: Standard errors in parentheses

      *** p<0.01, ** p<0.05, * p<0.1

**Source**: Computed by the authors

Since the $\chi^2 - p$-values are greater than the significant level of 5% (0.05), we reject the null hypothesis and conclude that GDP growth neither causes population growth, nor does population growth cause GDP growth. The Granger causality test results revealed no causality between population growth and economic growth in Tanzania (Table 3).

**Table 3: Granger Causality Tests Results**

| Null Hypothesis | $\chi^2$-Statistic | df | Probability | Conclusion |
|---|---|---|---|---|
| GDP Growth does not Granger Cause Population Growth | 2.071 | 4 | 0.723* | |
| | | | | Neutral |
| Population growth does not Granger Cause GDP Growth | 5.4337 | 4 | 0.246* | |

**Note**: *Denotes rejection of the null hypothesis at 5% significance level
**Source**: Computed by the authors

The study used the lag selection criteria, namely the Akaike Information Criteria (AIC). The results of this selection criteria are reported in Table 4. The decision rule is to choose the model with the lowest value of the information criteria. As noted by Enders (1995), this ensures that the error term is mis-specified.

**Table 4: Results of the Var Lag Selection**

| Lag length | AIC | HQIC | SBIC |
|---|---|---|---|
| 0 | 4.2189 | 4.2492 | 4.3009 |
| 1 | 1.8349 | 1.9256 | 2.0807 |
| 2 | 0.0425 | 0.1935 | 0.4521 |
| 3 | -1.1269 | -0.9155 | -0.5535* |
| 4 | -1.2650* | -0.9931* | -0.5278 |

**Source**: Computed by the authors

The AIC lag selection results in Table 4 point to the use of 4 lag as the most appropriate lag length that would minimize the value of the selection criteria. Based on the results in Table 4, the study employed the use of 1 lag.

An impulse response analysis helped trace the impact of a one standard deviation shock to the innovations on the current and future values of all the endogenous variables of the system. Plotting the impulse response functions was a better way of tracing the time path of the system variables as they responded to various shocks over time.

The objective of the study was to determine the response of population growth due to shocks in economic growth and vice versa. The use of impulse response functions achieved this, and the results are shown in Figure 4. An impulse response function traces the effect of a one standard deviation shock to one of the innovations on the current and future values of the endogenous variables. A shock to the ith variable directly affects the ith variable, and is also

transmitted to all of the endogenous variables (Enders, 1995). The plots and impulse responses that follow summarize the results of the shock evaluation, indicating the responses of each variable over the 47 years horizon to one standard deviation positive shock to each variable.
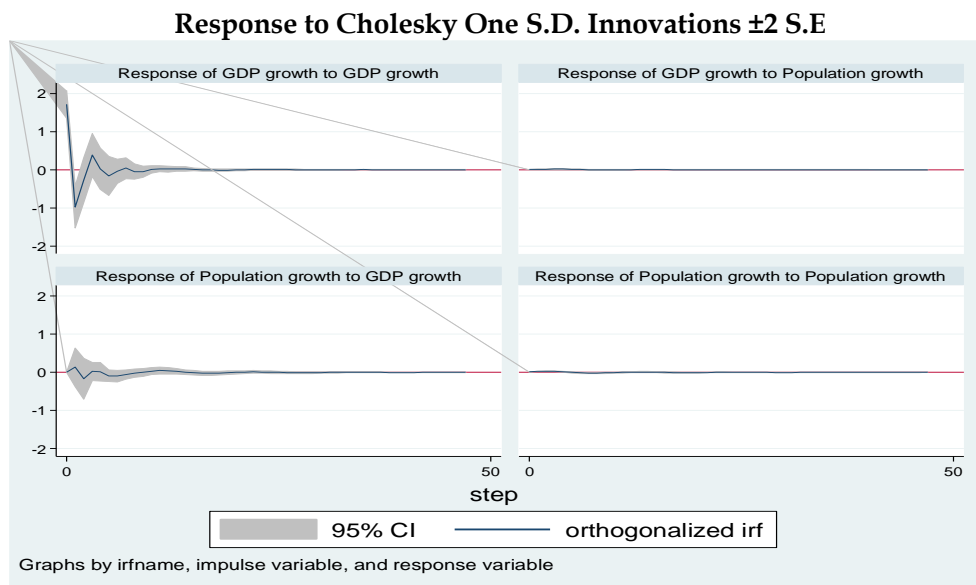
**Response to Cholesky One S.D. Innovations ±2 S.E**



**Figure 4: Impulse Response Graphs**
**Source**: Computed by the authors

The impact of one standard deviation shock on population growth and economic growth is shown in Figure 4. The response to one standard deviation to population growth resulted in a stable time path with respect to economic growth, as shown in Figure 4. This effect begins in a positive territory and lasts for six years on the negative part before shifting to a positive environment, and keep on fluctuating between negative and positive before dissolving out.

This phenomenon could be attributed to unstable expenditure on health care by the government in the improvement of child survival through various government programmes. For example, the substantial increase in childhood immunization and vaccination coverage levels at the national level have mostly contributed to the overall drop in child mortality in Tanzania. Another important initiative is the improvement in crucial malaria indicators such as the use of treated mosquito nets being provided by the government for preventive treatment of malaria during and after pregnancy, and to prevent childhood fever. The phenomenon could be further contributed by the increased expenditure by the government on education within the country; and also the expansion of educational facilities, mostly from private entrepreneurs. Due to

increase in population, the demand for education services is high, leading to the government's increased allocation to the sector and the subsequent expansion.

The evidence on the relationship between population growth and economic growth confirms that this varies among countries. For example, Tsen and Furuoka (2005) found a long-run equilibrium relationship between population growth and per capita GDP growth in Malaysia. Klasen and Lawson (2007) examined the relationship between population growth and economic development in Uganda, and their empirical findings indicated a negative impact of population growth on economic development. Dawson and Tiffin (1998) used time-series data to analyse a long-run relationship between India's population growth and economic development, and could not establish a long-run equilibrium relationship between population growth and economic development in the country. Thornton (2001) conducted similar research on the long-run relationship between population growth and economic development in seven Latin American countries, including Argentina, Peru, Brazil, Chile, Colombia, Venezuela, and Mexico. The findings were that a long-run relationship between population and real per capita GDP did not exist.

The response to one standard deviation innovation to population growth resulted in a stable time path that declines to zero for economic growth, as shown in Figure 4. The effect of a one standard deviation shock of economic growth on population growth lasted for seven years on the positive territory. This result supports Becker (1981), who found out that when a country is in a demographic transition, population growth increases with an increase in economic growth in the short-run.

An increase in the country's economic growth leads to growth in population up to the third year, and then starts to decline; and the impact disappears out after eight years towards its original path. Considering the causality from economic growth to population growth first, it is likely that in the short-term, high economic growth in a developing country will increase population growth, mainly through reducing mortality rates. This is a typical process of a country beginning a demographic transition, which initially increases population growth rates.

In the long term, however, economic growth will likely reduce population growth as wealthier parents choose smaller families, which will reduce population growth, as in the case of rich countries.

Variance decomposition provides a different method of depicting the system dynamics. Impulse response functions trace the effects of a shock to an endogenous variable on the variables in the VAR. By contrast, variance decomposition decomposes variation in an endogenous variable into the component shocks to the endogenous variables in the VAR. The variance decomposition gives information about the relative importance of each random innovation to the variables in the VAR (see Table 5 and Figure 5).

**Table 5: IRF Results**

| step | (1) oirf | (1) Lower | (1) Upper | (2) oirf | (2) Lower | (2) Upper |
|---|---|---|---|---|---|---|
| 0 | 1.719 | 1.352 | 2.087 | 0.002 | -0.002 | 0.006 |
| 1 | -0.982 | -1.534 | -0.429 | 0.007 | -0.002 | 0.016 |
| 2 | -0.274 | -0.859 | 0.310 | 0.012 | -0.002 | 0.025 |
| 3 | 0.387 | -0.175 | 0.948 | 0.015 | -0.001 | 0.031 |
| 4 | 0.024 | -0.517 | 0.566 | 0.016 | -0.001 | 0.032 |
| 5 | -0.162 | -0.671 | 0.346 | 0.011 | -0.003 | 0.025 |
| 6 | -0.039 | -0.354 | 0.275 | 0.003 | -0.008 | 0.014 |
| 7 | 0.040 | -0.238 | 0.318 | -0.004 | -0.014 | 0.007 |
| 8 | -0.050 | -0.250 | 0.150 | -0.008 | -0.020 | 0.004 |
| 9 | -0.054 | -0.199 | 0.091 | -0.009 | -0.022 | 0.003 |
| 10 | 0.011 | -0.089 | 0.111 | -0.008 | -0.019 | 0.004 |
| 11 | 0.026 | -0.056 | 0.108 | -0.004 | -0.014 | 0.006 |
| 12 | 0.015 | -0.066 | 0.095 | -0.000 | -0.009 | 0.009 |
| 13 | 0.019 | -0.042 | 0.080 | 0.003 | -0.006 | 0.012 |
| 14 | 0.021 | -0.039 | 0.081 | 0.005 | -0.004 | 0.014 |
| 15 | 0.008 | -0.032 | 0.048 | 0.005 | -0.004 | 0.013 |
| 16 | -0.005 | -0.038 | 0.028 | 0.003 | -0.005 | 0.012 |
| 17 | -0.010 | -0.042 | 0.023 | 0.001 | -0.007 | 0.009 |
| 18 | -0.011 | -0.042 | 0.020 | -0.001 | -0.008 | 0.007 |
| 19 | -0.011 | -0.041 | 0.020 | -0.002 | -0.009 | 0.005 |
| 20 | -0.007 | -0.035 | 0.021 | -0.002 | -0.009 | 0.004 |
| 21 | -0.001 | -0.025 | 0.023 | -0.002 | -0.008 | 0.004 |
| 22 | 0.003 | -0.018 | 0.024 | -0.001 | -0.007 | 0.005 |
| 23 | 0.005 | -0.014 | 0.025 | -0.000 | -0.006 | 0.006 |
| 24 | 0.006 | -0.013 | 0.025 | 0.001 | -0.004 | 0.006 |
| 25 | 0.004 | -0.014 | 0.023 | 0.001 | -0.003 | 0.006 |
| 26 | 0.002 | -0.015 | 0.020 | 0.001 | -0.003 | 0.005 |

**Notes:** 95% lower and upper bounds reported
(1) irfname = GPr, impulse = dGDP_r, and response = dGDP_r
(2) irfname = GPr, impulse = dGDP_r, and response = dPop_r
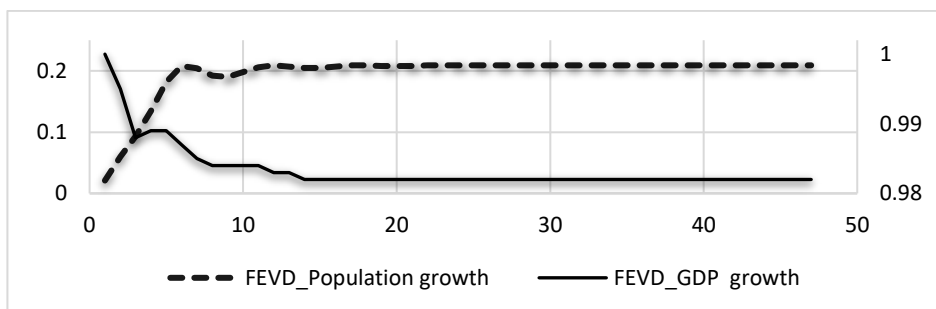
**Source**: Computed by the authors



**Figure 5: Variance Decomposition of GDP Growth Graph**
**Source**: Computed by the authors

The variations in economic growth rates brought about by changes in population growth were analysed. This was an alternative method to impulse response functions to examine the effects of shocks on the economic growth rate. The results of the variance decomposition analysis of economic growth rate show that all the variations in economic growth rate were due to its shocks at 100% in the first year. This implies that population growth did not contribute to the variations in economic growth in the first year. The variations of own shocks in economic growth were reduced to 99.5% in the second year. In the third year to the seventh year, the variations reduced to 99%, and continued to reduce as the forecasting horizon increased up to 98.2% (see Table 6 Column 2).

**Table 6: FEVDs Results for GDP Growth and Population Growth**

| (1)  | (1)   | (1)   | (2)   | (2)   | (2)   |
|------|-------|-------|-------|-------|-------|
| step | FEVD  | Lower | Upper | FEVD  | Lower | Upper |
| 1    | 1     | 1     | 1     | 0.021 | -0.065 | 0.106 |
| 2    | 0.995 | 0.960 | 1.030 | 0.060 | -0.089 | 0.209 |
| 3    | 0.988 | 0.920 | 1.057 | 0.093 | -0.109 | 0.294 |
| 4    | 0.989 | 0.923 | 1.055 | 0.134 | -0.128 | 0.396 |
| 5    | 0.989 | 0.921 | 1.057 | 0.182 | -0.138 | 0.503 |
| 6    | 0.987 | 0.919 | 1.055 | 0.208 | -0.139 | 0.555 |
| 7    | 0.985 | 0.914 | 1.056 | 0.204 | -0.136 | 0.545 |
| 8    | 0.984 | 0.912 | 1.056 | 0.192 | -0.133 | 0.516 |
| 9    | 0.984 | 0.912 | 1.055 | 0.190 | -0.133 | 0.513 |
| 10   | 0.984 | 0.912 | 1.055 | 0.198 | -0.136 | 0.531 |
| 11   | 0.984 | 0.912 | 1.055 | 0.206 | -0.138 | 0.551 |
| 12   | 0.983 | 0.911 | 1.055 | 0.209 | -0.139 | 0.557 |
| 13   | 0.983 | 0.910 | 1.055 | 0.207 | -0.139 | 0.553 |
| 14   | 0.982 | 0.910 | 1.055 | 0.205 | -0.139 | 0.548 |
| 15   | 0.982 | 0.910 | 1.055 | 0.205 | -0.139 | 0.549 |
| 16   | 0.982 | 0.910 | 1.055 | 0.207 | -0.138 | 0.553 |
| 17   | 0.982 | 0.910 | 1.055 | 0.209 | -0.139 | 0.556 |
| 18   | 0.982 | 0.909 | 1.055 | 0.209 | -0.139 | 0.557 |
| 19   | 0.982 | 0.909 | 1.055 | 0.208 | -0.139 | 0.556 |
| 20   | 0.982 | 0.909 | 1.055 | 0.208 | -0.139 | 0.555 |
| 21   | 0.982 | 0.909 | 1.055 | 0.208 | -0.139 | 0.556 |
| 22   | 0.982 | 0.909 | 1.055 | 0.209 | -0.139 | 0.556 |
| 23   | 0.982 | 0.909 | 1.055 | 0.209 | -0.139 | 0.557 |
| 24   | 0.982 | 0.909 | 1.055 | 0.209 | -0.139 | 0.557 |
| 25   | 0.982 | 0.909 | 1.055 | 0.209 | -0.139 | 0.557 |
| 26   | 0.982 | 0.909 | 1.055 | 0.209 | -0.139 | 0.557 |

**Notes:** 95% lower and upper bounds reported
(1) irfname = GPr, impulse = dGDP_r, and response = dGDP_r
(2) irfname = GPr, impulse = dGDP_r, and response = dPop_r
**Source**: Computed by the authors

Furthermore, the variations in population growth rate were due to its own shocks is at 2.1% in the first year. This implies that economic growth contributed to the variation in population growth at 97.9% in the first year. The variation of own shocks in population growth increased to 6% and 9% in the second and third years, respectively. This trend continued to decline as the forecast horizon increased up to 20.9% in the years between 22nd and 47th (see Table 6 Column 5).

**Conclusion**
The findings of the study support short-run and long-run relationships between population and economic growth in Tanzania. They support the hypothesis that population and economic growth drive each other in the country. The results of the causality tests suggest no causality, while causality was assumed to run from population to economic growth; or from economic growth to population growth. Overall, the relationship between population and economic growth is strong and positive in Tanzania throughout the analysis. This suggests that Tanzania seems to be in the second stage of demographic transition, called the post-Malthusian regime. The relationship between economic growth and population growth remains highly strong and positive because of low births and death rates. These findings support the population-driven economic growth hypothesis, which states that population growth in a country promotes its economic growth development.

**Policy Recommendations**
Though the findings show no causation between population growth and economic growth, the response due to shocks results indicated a positive correlation between population and economic growth in Tanzania. The carefully planned population growth strategy, coupled with institutional and policy changes, are beneficial to this country. A well-managed population expansion will ensure that both the population and economy are complementing each other without concerns that population expansion will lead the country to famines and the lack of other socio-economic facilities since it is inadequate government policies, rather than population growth, which are responsible for ailments, including famines, that overwhelm most developing nations.

The government should also ensure that the economy grows at a higher rate than the population growth. This will ensure that the increasing demand for services arising from the population growth is met. Having a larger, healthier, and better-educated workforce will only bear economic fruit if the extra workers can find jobs. Open economies, flexible labour forces, and modern institutions that can gain the population's confidence and markets alike may help countries reap the potential benefit created by their demographic transition. Openness to trade can be a crucial driver of economic growth, helping to significantly boost the benefits a country receives from demographic transition.

Population growth can influence economic growth through two essential channels: technical progress, and economies of scale. An increase in population leads to innovations. Technological advances, in turn, promote productivity and economies of scale, hence national output. There is a need for the government to change the education system to ensure that new training methods -- which develop existing skills and creative skills where they do not exist -- are implemented. There is also a need to put in place training policies that will strengthen the competitive capacities of the workforce and increase competitiveness. Education is the principal supplier of highly skilled and effective human resources. The most important thing is to amend and reform higher education and make it a useful tool in the service of the development process, and link it to the global market to meet the demands of the labour market and create new job opportunities for the population.

Sustainable development aims to create and improve an environment in which all people can expand their capabilities, which requires good governance. That concept is distinguished by its transparency and accountability, as well as its effectiveness and justice. The provision of employment opportunities is the peak of any economic and social reform plan that aims to improve the quality of life by achieving sustainable human development. In that respect, the role of good governance in providing job opportunities needs to be emphasized. A better political environment would also encourage private investment since its contribution to economic growth cannot be underestimated.

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