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Contribution of Population Growth on Economic Growth in Rwanda (1992-2022)

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ABSTRACT: This study examines the impact of changes in population size on economic growth in Rwanda between 1992 and 2022. The research methodology involves the use of secondary data from World Bank development indicators. The key variables analysed include population size, gross capital formation expenditure, and gross domestic product growth rate. A multivariate time series analysis was used to examine the impact of population on economic growth in this study. Diagnostic tests were conducted, and the results indicated that the model was sound. The variables were not significantly affected by heteroskedasticity and serial correlation problems. During the unit root test, it was found that all variables were stationary at the level using intercept and trend. This led to the use of the Ordinary Least Square model. The findings reveal a complex relationship between population dynamics, gross capital formation, and economic growth in Rwanda. The R-squared value was found to be close to one, indicating that population growth and gross capital formation explain economic growth to the greatest extent. The findings from the study showed that population has negative relationship with economic growth. Gross capital formation also plays a crucial role in driving economic growth by facilitating investment activities across different sectors.

KEYWORDS: Gross Domestic Product, Gross Capital Formation, Population.

INTRODUCTION

Rwanda, a landlocked country in East Africa, has experienced significant economic growth over the past few decades (Sebikabu, Ruvuna, & Ruzima, 2020) .This growth can be attributed to various factors, including population dynamics and gross capital formation. Population plays a crucial role in shaping economic growth. In the case of Rwanda, the country has seen a steady increase in its population over the years. While this may present challenges in terms of resource allocation and the provision of basic services, it also presents opportunities for economic development. A larger population means a larger labour force, which can contribute to increased productivity and overall economic output (Hanushek & Kimko, 2000). However, it is essential to ensure that population growth is accompanied by quality education and skill development programmes to fully harness this potential. By investing in human capital through education and training initiatives, Rwanda can equip its growing workforce with the necessary skills for higher productivity and innovation (Blimpo & Owusu, 2019).

(Klasen and Lawson , 2007). present theoretical arguments and empirical evidence to demonstrate that robust population growth fosters economic growth. Conversely, other scholars have identified evidence that challenges this conclusion (Malthus, 1970). Furthermore, it has been demonstrated that the effects of population growth are not uniform across all countries. The level of a country's development, the source or nature of the population growth, and other factors that lead to non-uniform impacts of population growth must be considered. The link between population growth and growing economic output has been extensively studied (Heady and Hodge , 2009). A considerable number of analysts have postulated that economic growth in high-income nations is likely to be comparatively slow in the approaching years, given that population growth in these nations is forecasted to become significantly sluggish.

Some scholars argue that population growth has been and will continue to be challenging due to the finite resources available on Earth, which will result in a reduction in long-term possible evolution (Linden, 2017). Population growth affects numerous aspects, including the age structure of a nation's population, the movement of human resources, economic disparities, and the dimensions of a nation's work force (Linden, 2017). These factors influence population growth and human development, and are exaggerated by overall economic growth (Peterson and Wesley , 2017). This study employs long-term data in conjunction with an evaluation of theoretical and observed work on the relationship between population growth, total output and capital formation output, agriculture development, foreign direct investments, and the consumption price index. The objective is to measure their impact on economic

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growth and, more generally, on economic development. (Piketty, 2014) demonstrated that fiscal growth is comprised solely of a demographic component and an economic element. The economic component is instrumental in achieving a standard of living that is perceived as optimal. In addition to examining the potential impact of population growth on economic development, literature also studies the relationships between them to evaluate the inferences that can be drawn about their probable relationships for growing economies (Peterson and Wesley , 2017).

The long-term evolution of the population and total economic production in various regions and selected countries is evidenced by statistical analysis in World Economics (2016) and Maddison (2001). In the past, agriculture was a significant source of livelihood for most developing countries. The conventional (Malthusian) school of thought posits that rapid population growth leads to inferior economic growth and poverty. The second perspective takes the opposite view and argues that a higher population growth rate raises the stock of human capital, leading to economic growth. Finally, the change theory maintains that population growth is in part due to changes in incomes. In developing countries where the association between population growth and economic progress can be seen as positive, the demographic situation leads to economic development, which in turn leads to an improvement in living standards.

(Simon, 1996) emphasizes the positive side of population growth when he states that a human being is a vigorous and indispensable element, and that they contribute to economic growth. The impacts of demographic changes on economic growth are matched with the emergence of the 'technology gap' or 'convergence' model in economic progress literature (Barro and Sala-i-Martin , 1991). The positive benefits of population size on agriculture have been the subject of the most extensive debate in the literature. Higher population concentrations can result in lower per unit costs and an increase in the competencies of transport, irrigation, additional services, markets, and communication (Glover and Simon , 1975). Boserup's (1965, 1985) work is perhaps the most frequently cited, in which he observes that increasingly productive agricultural tools become economically beneficial with efficiency improvements in response to developed land densities. In his study on the hypothetical and empirical examination of the influence of human capital on economic growth in Ukraine, Osipian (2009) found a positive impact on economic growth.

Ahlburg (1996) posits that if human capital per capita is sufficiently large, the economy will transition to a stable state of growth. In this state, consumption per capita will increase at a slower rate than human capital, provided that the population is growing and that the production of consumer goods does not keep pace with it. Despite this, the positive links between population growth and economic growth, which lead to economic development, are discussed more. A considerable number of educationalists have identified evidence indicating that an educated population is a significant factor in economic growth (Lucas 1988; Hanushek and Kimko, 2000). However, other researchers have challenged these findings, leading to the emergence of the view that human capital plays an important role in economic growth (Levine and Renelt, 1992). Trade openness has been employed extensively in empirical literature as a key factor influencing economic growth in the long term. A substantial corpus of empirical literature supports the view that trade openness has a positive impact on economic growth. Nevertheless, despite these positive perceptions about the effects of trade openness on economic growth, some researchers have questioned the robustness of the outcomes of these studies (Acemoglu and Robinson , 2008).

(Tayebwa, 2000) defines economic growth as a continuous increase in the volume of goods and services produced in an economy over a specified period. To ascertain whether an economy is growing or declining, the total value of goods and services produced is monitored and measured on a regular basis by relevant government departments.

RELATED LITERATURE

The impact of population and gross capital formation on economic growth is a topic of significant interest to researchers, with numerous studies exploring the relationship between these factors and a country's development. The following section presents the contributions of other researchers to the impact of population and gross capital formation on economic growth.

An analysis of the links between demographic changes and economic growth (David et al, 1999)in Asia during 1965–1990 demonstrated that the overall rate of population growth had a minimal effect on economic growth. The findings of Afzal (2009) and Boadu (1994) indicate that population growth has a negative effect on economic growth. Kelley and Schmidt (1994) demonstrated that population growth has a negative effect on economic growth, as measured by the growth degree of per capita gross domestic product (GDP). GDP growth can be influenced by a high needs ratio, which occurs when rapid population growth results in a greater number of children and youth relative to the workforce. As a consequence of the fact that administrations and households spend a

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greater amount than what the children can rapidly refund in economic production, especially as modern schooling and healthcare services replace child labour, economists anticipate that consumption related to children will delay household investments, increase government expenditure, and eventually impact GDP growth.

(Kelley, 1988) Some economists view overpopulation as an opportunity to stimulate economic growth, whereas others perceive it as a challenge (Rohan, 1999). Two prominent theories are frequently cited in the academic literature. One postulates that population growth enhances economic growth, which in turn benefits a nation's economy by accelerating the rate of economic expansion and facilitating development. This theory was initially proposed by Solow, while the second was developed by Thomas Malthus.

(Deyuan, 2018) conducted an investigation into the interrelationship between economic growth, electricity access, energy use, and population growth in Pakistan over the period 1990–2016. They employed an autoregressive distributed lag (ARDL) bounds testing approach for co-integration in order to study the causal relationship between the variables. The findings indicated that in the long run, the relationships between the variables, access to electricity by the population, access to electricity by the urban population, and energy usage had a positive impact on economic growth, while electricity access to the rural population had a negative impact on economic growth.

(Ali and Amin , 2013)conducted a study investigating the impact of population growth on economic development in Pakistan. They employed the ARDL approach to examine the relationship between population and economic development, and their findings indicated that population growth had a positive and statistically significant effect on economic development. The study found that the primary challenge associated with a high population growth rate was the failure to employ the newly created workforce, its management, and even to provide for its basic needs. This became a significant challenge for the Government of Rwanda in its efforts to understand the impact of population growth on economic development. Ahlburg (1996) posits that if the ratio of human capital to population is sufficiently high, the economy will reach a state of equilibrium, where the rate of growth in consumption per capita will slow down relative to the growth in human capital. This is contingent on the population growth rate being greater than the rate of production of consumer goods.

RESEARCH METHODS

This study employs an ex post facto design, utilising secondary data to ascertain the relationship between independent and dependent variables. The collected data enables the examination of the correlation between population, gross domestic product and gross capital formation. The study is based on time series data for secondary data from 1992 to 2022 for the economic variables focused in the analysis. The data were collected from the World Bank Development Indicators (WDI, 2019). The purpose of this study is to assess the effect of FDI on the economic growth of Rwanda from 1970-2019, utilising data from the World Bank nationals' accounts and the National Bank of Rwanda. The study has examined time series data over a period of thirty years. Multiple regression analyses were employed to assess the relationship between the independent variable (population) and the dependent variable (GDP growth). Various tests were conducted to ascertain the suitability of the model for prediction purposes, including normality tests, serial correlation, heteroscedasticity and stability tests. The econometric package used for empirical analysis and estimation was eviews12.

The model specification was as follows:

Equation: $GDP_t = \beta 0 + \beta 1 POP_t + \beta 2 GCF_t + E_t$.

Where:

GDP_t = Gross Domestic Product at time t

POP_t = Population at time t

GCF_t = Gross Capital Formation at time t

E_t = Error term

RESULTS AND DISCUSSION

This section presents the results of various tests conducted using Evies 12, accompanied by a discussion of the findings.

Data Transformation

The data used for this study were subjected to logarithmic transformation for two main reasons. Firstly, the transformation allows the regression coefficients to be interpreted as elasticities, as outlined by Asteriou and Hall (2007). Secondly, many economic time series exhibit a strong trend, which can be caused by an underlying growth process. When this is the case, a plot of the series reveals

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an exponential curve. In such cases, the exponential growth component dominates other features of the series (e.g., cyclical and irregular components of the series) and thus obscures the more interesting relationship between this variable and another growing variable. Therefore, taking the logarithm of such a series effectively linearises the exponential trend.

Unit Root Testing (Stationarity Test)

In the initial stage, the augmented Dickey-Fuller (ADF) test, as proposed by (Fuller and Dickey , 1981), is employed to assess the stationarity of all variables. The outcomes of this assessment are presented in the subsequent section.

Augmented Dickey-Fuller test

The results of the unit root test indicate that the series is stationary at the level when including the trend and intercept. The table below presents the summary and conclusion of the unit root test of variables.

Table 1: The results of the stationarity test of variables at the level including the intercept and trend are presented below.

Variables	p-values at level	Conclusion
POP	0.0067	Stationary
LOG(GCF)	0.0273	Stationary
LOG(GDP)	0.0082	Stationary

Researcher's computation using Eviews 12.

The results of the stationarity test indicate that all variables are stationary at the level, which led to the conclusion that the Ordinary Least Square model (OLS Model) is the most appropriate for this analysis.

Table 2: results from the regression model

Dependent Variable: LGDP
Method: Least Squares
Date: 04/16/24 Time: 06:42
Sample: 1992 2022
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
POP	-0.000437	0.002168	-0.201515	0.8418
LGCF	0.736074	0.011850	62.11493	0.0000
C	7.104003	0.240942	29.48430	0.0000

R-squared	0.993149	Mean dependent var	22.10756
Adjusted R-squared	0.992659	S.D. dependent var	0.792004
S.E. of regression	0.067857	Akaike info criterion	-2.451056
Sum squared resid	0.128929	Schwarz criterion	-2.312283
Log likelihood	40.99137	Hannan-Quinn criter.	-2.405820
F-statistic	2029.400	Durbin-Watson stat	1.114766
Prob(F-statistic)	0.000000		

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The regression results indicate that the R-squared (R^2) value of 0.99 signifies that 99% of the explanatory variables account for the fluctuations in the dependent variable. This implies that the independent variables (LGFC and POP) explain 99% of the changes in the logarithm of gross domestic product (LGDP). This suggests that GFC and POP are responsible for the behaviour of gross domestic product to a high degree of certainty.

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An F-statistical probability (Prob(F-statistic)) of less than 0.05 indicates that all the coefficients of the variables in the regression result are statistically significant for GDP. The Durbin-Watson (DW) statistic, as shown in the regression analysis, is 1.115, which is close to 2, indicating that there is a low probability of non-autocorrelation.

NORMALITY TEST

The objective of this test is to ascertain whether the error term adheres to a normal distribution. The normality test employed is the Jarque-Bera (JB) statistic, which follows the Chi-square distribution.

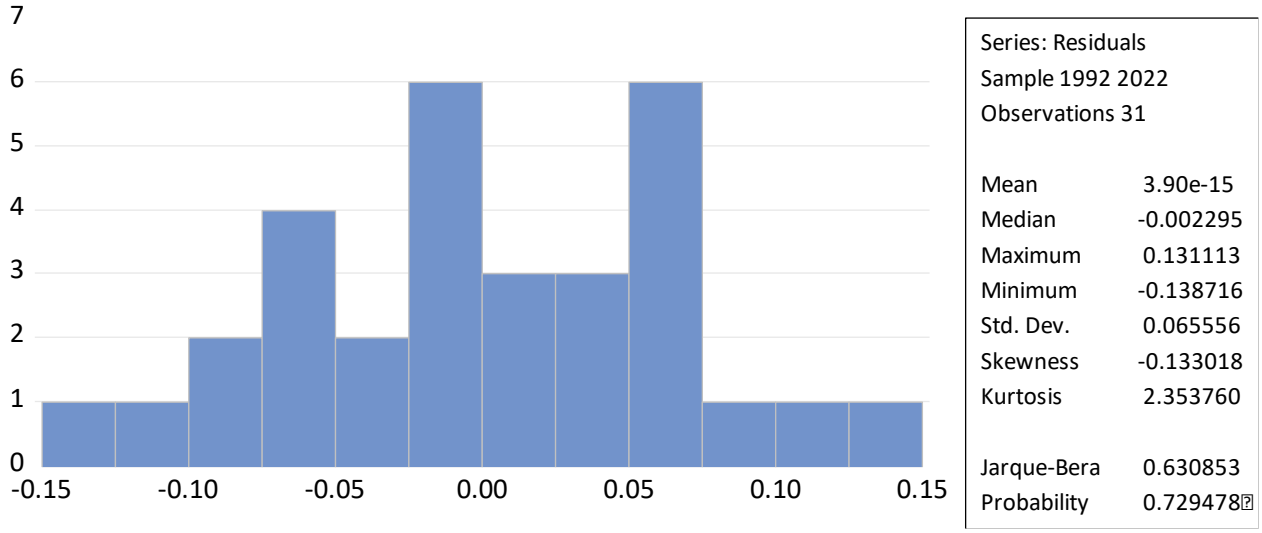

Figure 1: Normality test

The probability of the Jacque-Bera test statistic being greater than 72.9% is greater than the 10% level of significance. Therefore, we conclude that the residuals are normally distributed, which implies that the model is a good fit.

SERIAL CORRELATION

The objective of this test is to ascertain whether the model exhibits autocorrelations of residuals. This implies that errors from a given period influence the errors of the subsequent period, t+1. The Breusch-Godfrey Serial Correlation LM Test is employed to achieve this.

Table 3: Serial correlation

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.958830	Prob. F(2,26)	0.0695
Obs*R-squared	5.747523	Prob. Chi-Square(2)	0.0565

The results of the probability chi-square test indicate that the null hypothesis, which states that there is no serial correlation of errors in the model, can be accepted with a probability of 5.65%, which is greater than 5%.

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HETEROSCEDASTICITY TEST

Table 4: Heteroscedasticity test.

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	3.184590	Prob. F(2,28)	0.0567
Obs*R-squared	5.744814	Prob. Chi-Square(2)	0.0566
Scaled explained SS	3.172344	Prob. Chi-Square(2)	0.2047

According to the above results, for probability chi-square (2) of obs*R-squared (0.0565) which is greater than 0.05 leads us to accept the null hypothesis that there is no heteroskedasticity. This means that the model is free from heteroskedasticity.

STABILITY TEST

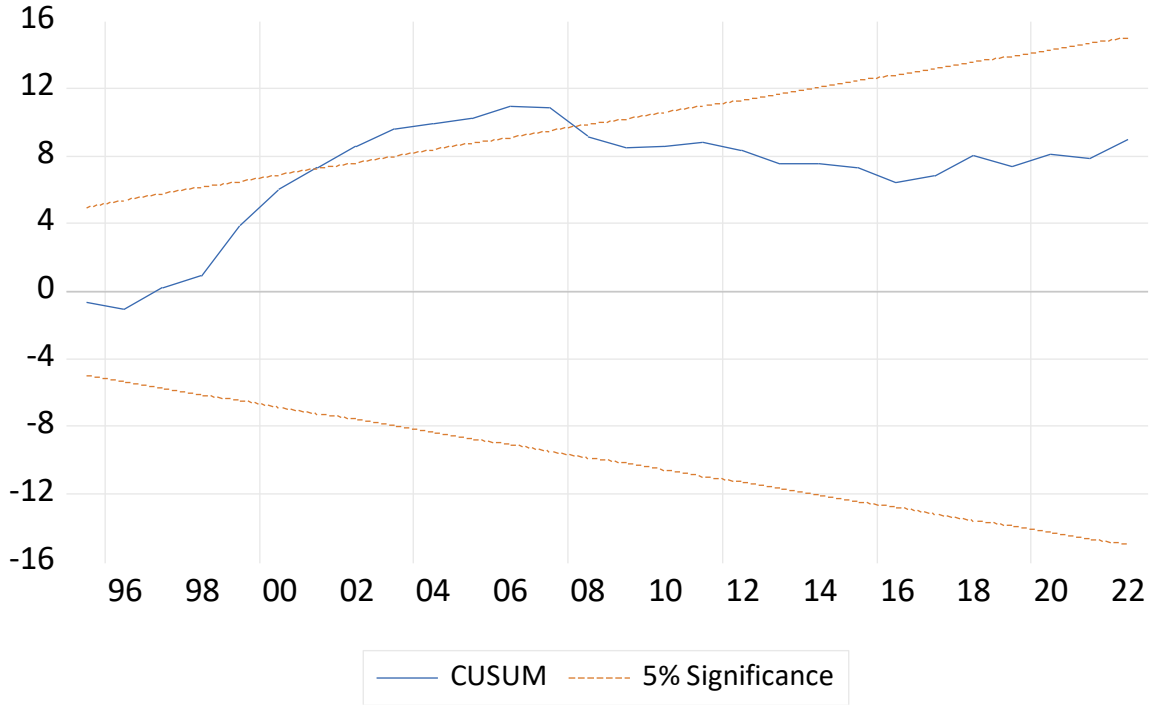

Figure 2: Cusum test (Cusum test)

The above graph illustrates that the parameters of the model are stable, as evidenced by the majority of the blue line remaining within the red lines. The straight line represents the critical bounds at 5% significant levels.

DISCUSSION

Gross Domestic Product and Population

The regression results and diagnostic tests indicate that the variables were significant at the level of significance. Further tests were conducted to assess the model's goodness of fit. These tests demonstrated that the model was free from serial correlation, heteroscedasticity, and that the R-squared value was close to one. Additionally, a stability test was performed, which proved that the model is stable. A negative relationship exists between gross domestic product (GDP) and population, with an increase of 1% in population resulting in a decrease of 0.000437 in GDP. This negative relationship is consistent with the findings of other researchers on the contribution of population to economic growth. For instance, Kelley and Schmidt (1994) demonstrated that

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population growth has a negative effect on economic growth, while Afzal (2009) and Boadu (1994) showed that population growth has a negative impact on economic growth.

Gross domestic product and Gross capital formation

The results of the regression equation and the various diagnostic tests indicated that there is a positive relationship between gross domestic product and gross capital formation. Specifically, a 1% increase in log gross capital formation is associated with a 0.736074% increase in log gross domestic product.

CONCLUSION

The results from Eviews 12, which included various diagnostic tests such as normality tests, serial correlation tests, heteroscedasticity and stability tests, demonstrated that the model was suitable for prediction. The regression equation indicated a negative relationship between gross domestic product and population, with an increase of 1% in population resulting in a decrease of 0.0437% in log gross domestic product. Furthermore, the results have demonstrated a positive correlation between gross domestic product and gross capital formation. Specifically, a 1% increase in log gross capital formation is associated with a 0.736074% increase in log gross domestic product.

The results demonstrated that the R-squared value was 99%, indicating that the independent variables accounted for 99% of the variation in the dependent variable. Additionally, the probability (F-statistic) was 0.0000, which was less than 5%, suggesting that the independent variables collectively explained the dependent variable, ceteris paribus. This section of the econometric analysis has demonstrated that population growth has had a negative impact on economic growth in Rwanda between 1992 and 2022. In summary, population growth has been detrimental to the Rwandan economy. To improve the Rwandan economy, it is necessary to control population growth to the extent that it does not have a negative effect on economic growth. This can be achieved through family planning and other measures to reduce population growth in Rwanda.

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