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Addressing Demographic Challenges: Strategies for Sustainable Economic Growth in Pakistan

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Abstract

This study examines the relationship between population growth and economic growth in Pakistan, acknowledging the challenges posed by rapid population increases. Utilizing statistical techniques such as the Augmented Dickey-Fuller (ADF) unit root test, cointegration analysis, and Auto-regressive Distributed Lag (ARDL) models, the research investigates the impact of demographic trends on economic indicators. Economic growth serves as the dependent variable, while independent variables include population growth, investment levels, fertility rates, employment rates, and education expenditure. The findings reveal a negative correlation between population growth and economic growth in Pakistan. The expanding population is identified as a major factor contributing to socioeconomic challenges such as rising unemployment and increasing pressure on resources. These challenges hinder sustainable economic progress and exacerbate existing structural issues within the economy. In response to these findings, the study recommends the implementation of targeted awareness programs to promote population control measures. Additionally, it urges the Government of Pakistan to adopt proactive policies to address the adverse effects of overpopulation. Strategic interventions, including investment in education, healthcare, and family planning services, are essential to managing demographic growth effectively. By addressing population-related challenges through informed policies and awareness initiatives, Pakistan can foster a more balanced economic trajectory. Sustainable population management strategies will help alleviate pressure on resources, improve living standards, and support long-term economic development. The study highlights the critical need for integrating population control efforts with broader economic planning to ensure stable and inclusive growth.

Keywords: Population Growth, Economic Growth, Pakistan, Demographic Challenges

JEL Codes: J11, O15, O53

1. INTRODUCTION

At the beginning of the 21st century, the global population stood at around 6 billion and has continued to increase steadily. Similar demographic pressures have been highlighted in socio-economic analyses, including Ali and Audi (2016), Marc and Ali (2016), and Ali and Ahmed (2014), who note that population size strongly interacts with economic development. Each year, approximately 75 million individuals are added to the world population. Pakistan ranks as the sixth most populous country globally, with a population of approximately 191.71 million. This marks an increase from 188.0 million in 2014. Despite the increase, Pakistan's Population Growth Rate declined from 1.95 percent in 2014 to 1.92 percent in 2015. Population dynamics such as these are central to public-policy discussions, as emphasized by Ali and Bibi (2017), Ali and Zulfiqar (2018), and Sajid and Ali (2018), who view demographic change as an important macroeconomic determinant. Indeed, global population distribution reflects major disparities between developed and developing countries. Developing countries—especially in Asia—contribute nearly 80% of the world's total population. Demographic management practices in countries such as China have been evaluated by Maurya (2018), Manzoor and Agha (2018), and Hussain (2018), who stress that highly populated nations must manage both labor-force pressures and economic absorption capacity. Conversely, many developing economies struggle to meet basic needs amidst rapid growth. This is consistent with challenges identified by Ali et al. (2016) in Pakistan, Okurut and Mbulawa (2018) in Botswana, and Wiafe (2018) in Ghana, where high population burdens strain education, employment, and resource availability.

The issue of high population is particularly prevalent in Asian countries, where rapid growth poses challenges to economic stability and sustainability. The relationship between population and economic growth is widely debated and is linked with structural economic analyses such as Ali and Naeem (2017), Iqbal (2018), and Ahmad (2018), who note that demographic burdens can suppress productivity and macroeconomic performance. High population growth may strain resources, create unemployment, weaken healthcare provisions, and intensify urban pressures. Similar resource-constraint arguments are highlighted by Gorus and Groeneveld (2018), Zhang (2018), and Kumar (2018), who connect demographic pressures to environmental deterioration and energy shortages. In many cases, rapid population expansion redirects limited government funds from long-term development to short-term survival needs, consistent with findings by Asif and Simsek (2018) and Shahbaz (2018) regarding financial resource misallocation. Despite these challenges, an alternative view suggests that population growth can stimulate economic development. A large labor force can expand production capabilities, a view supported by Singh and Kumar (2018) and Koocheki (2018), who argue that labor abundance can drive industrial growth. Additionally, rapid demographic expansion can increase market size, stimulate consumption demand, and encourage investment, consistent with sectoral analyses by Asif and Simsek (2018) and Wali (2018). Population-driven urbanization may also foster innovation and structural diversification. This demographic dividend framework aligns with broader socio-economic contributions identified by Ali and Rehman (2015), Ali (2015), Marc and Ali (2017), and Ali and Ahmed (2014), who emphasize the importance of human capital and labor participation in development.

The findings of this population-growth study have significant implications for policymakers. Population-economy linkages, such as those detailed by Ali and Bibi (2017) and Ali and Zulfiqar (2018), highlight the need for informed strategies to regulate demographic trends. This includes promoting family planning, improving healthcare access, and strengthening education systems. Existing frameworks such as those discussed by Ali and Naeem (2017) and Ali et al. (2016) demonstrate that countries with effective population policies often experience higher employment capacity and more balanced development. Moreover, insights from Luna and Luna (2018), Clark and Adam (2018), and Muhieddine (2018) underscore that demographic pressures also shape energy use and environmental outcomes—factors critical for sustainability. The study also notes that population growth is connected to unemployment dynamics, echoing concerns raised by Riaz and Safdar (2018) and Khan and Ahmad (2018), where labor force growth often outpaces available employment opportunities. Addressing population growth may alleviate unemployment by balancing labor supply with job creation. While this study focuses primarily on demographic-economic interactions within Pakistan, further research could explore urbanization effects, migration patterns, and regional

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disparities—areas aligned with the empirical concerns of Zhang (2018), Wiafe (2018), and Okurut and Mbulawa (2018). Overall, this study adds to the extensive body of literature on population economics, complementing the broader socio-economic insights provided by Ali and Audi (2016), Marc and Ali (2017), Maurya (2018), and Ali et al. (2016), thereby informing future policy directions aimed at promoting sustainable development in Pakistan and beyond.

2. LITERATURE REVIEW

The study conducted by Velasco et al. (2016) sheds light on the intricate relationship between population growth and economic growth in Mexico. By employing cointegration analysis and Granger causality testing, the researchers aimed to elucidate the dynamic interplay between these two variables over a considerable time span from 1960 to 2014. In the short run, the findings suggest a nuanced relationship, wherein economic growth exerts a negative influence on population growth. This observation underscores the potential impact of economic factors on demographic trends, highlighting the role of economic conditions in shaping population dynamics within a relatively short time frame. However, in the long run, a different picture emerges, with population growth demonstrating a positive effect on per capita GDP, indicating that a larger population can contribute positively to economic output on a per capita basis. Conversely, per capita GDP was found to positively influence population growth, reflecting the reciprocal nature of the relationship between economic prosperity and population expansion over extended periods. The Granger causality test further elucidated the directional influence between population growth and per capita GDP, revealing bidirectional causality between these variables. This implies that changes in population size can Granger-cause changes in economic output per capita, and vice versa, suggesting a feedback loop wherein population and economic factors mutually influence each other's dynamics. The study by Velasco et al. provides valuable insights into the complex relationship between population growth and economic growth in Mexico, underscoring the need for policymakers to consider the dynamic interplay between demographic trends and economic conditions when formulating strategies for sustainable development and growth.

The study conducted by Essien (2016) provides insights into the relationship between population growth and economic growth in Nigeria. By utilizing time series data spanning from 1981 to 2013 and employing various econometric techniques such as the Augmented Cobb-Douglas Production Function, Johansen Cointegration Test, and ADF test, the researcher aimed to elucidate the impact of population growth on the economic performance of Nigeria. The findings of the study indicate a positive association between population growth and economic growth in Nigeria. Through the application of econometric analyses, it was observed that population growth has the potential to contribute to the overall economic expansion of the country. Specifically, the results suggest that population growth exerts a favorable influence on the growth performance of the Nigerian economy. The utilization of the Augmented Cobb-Douglas Production Function allowed for the examination of the relationship between population growth and economic output within the framework of a production function model. Additionally, the Johansen Cointegration Test facilitated the assessment of long-term equilibrium relationships between population growth and economic growth, while the ADF test helped ascertain the stationarity properties of the data. The study underscores the significance of population growth as a determinant of economic growth in Nigeria. By demonstrating the positive impact of population growth on economic performance, the findings provide valuable insights for policymakers and stakeholders involved in fostering sustainable development strategies. It highlights the importance of considering demographic factors in the formulation of economic policies aimed at promoting growth and prosperity in Nigeria.

The research conducted by Ali et al. (2015) sheds light on the relationship between population growth and economic growth in Bangladesh. By employing multivariate analysis techniques and utilizing data spanning from 1981 to 2014, the study aimed to elucidate the impact of rapid population growth on the economic dynamics of the country. The findings of the study suggest that rapid population growth poses a significant challenge to economic development in Bangladesh. The research highlights that the burgeoning population contributes to lower investment growth and diminishes the savings rate, which can impede overall economic progress. Through the application of various statistical tests such as the LM test, JB test, and HS test, the researcher aimed to rigorously examine the relationship between population growth and economic variables. Real GDP growth was considered as the dependent variable in the analysis, while independent variables included population growth, real gross domestic investment growth, real foreign investment growth, exports growth, and consumption. Through the examination of these variables, the study aimed to assess the multifaceted impact of population growth on economic performance. One of the key conclusions drawn from the study is that the relationship between population growth and economic growth is not consistently observed across different countries. This underscores the complexity of the issue and emphasizes the need for context-specific policy interventions. The study recommends that policymakers address the economic challenges posed by rapid population growth through targeted investments in family planning services. Additionally, initiatives aimed at promoting independent media and liberal education in educational institutions could help foster a societal shift towards smaller family sizes, thereby mitigating the adverse effects of population growth on economic development. The study provides valuable insights into the interplay between population dynamics and economic growth in Bangladesh. By highlighting the economic implications of rapid population growth and proposing policy solutions, the research contributes to the ongoing discourse on sustainable development in the country.

The research conducted by Tartiyus et al. (2015) investigated the impact of population growth on economic growth in Nigeria, utilizing data from the period 1980 to 2010. Through the application of various statistical methods including the Augmented Dickey Fuller (ADF) Unit Root test, Granger causality test, and Ordinary Least Squares (OLS) method, the study aimed to elucidate the relationship between population dynamics and economic performance. Real GDP was considered as the dependent variable in the analysis, while population growth, real gross domestic investment growth, real foreign investment growth, export growth, and private consumption as a percentage of GDP were included as independent variables. By examining these variables, the study sought to assess the impact of population growth alongside other economic factors on Nigeria's economic growth trajectory. The findings of the study revealed a positive relationship between population growth and economic growth in Nigeria. This suggests that, contrary to the experiences of some advanced countries, population growth may have a stimulative effect on economic activity in the Nigerian context. Based on these results, the study proposed several policy recommendations to leverage the positive relationship between population growth and economic growth. Firstly, it suggested maintaining the average rate of fertility in Nigeria to ensure a steady population growth rate conducive to economic expansion. Additionally, the study recommended implementing policies aimed at enhancing export growth as a means to further stimulate economic development. By encouraging export-oriented strategies, Nigeria could capitalize on its population growth to drive increased economic activity and

prosperity. By highlighting the positive association between population growth and economic performance in the Nigerian context, the study provides important considerations for policymakers and stakeholders seeking to foster sustainable economic development in the country.

The research conducted by Shah et al. (2015) aimed to investigate the relationship between economic growth and population growth in Bangladesh. Utilizing data from the period 1980 to 2005, the study employed a multiple linear regression model to analyze the interplay between these variables. The study considered GDP growth as the dependent variable, measured annually as a percentage, while population growth, growth in exports of goods and services, Foreign Direct Investment (FDI) as a percentage of GDP, and Gross National Income (GNI) per capita were included as independent variables. By examining these factors, the research sought to discern the impact of population dynamics alongside other economic indicators on the growth trajectory of Bangladesh's economy. The findings of the study indicated a negative correlation between economic growth and population growth in Bangladesh. This suggests that an increase in population may exert a dampening effect on the country's economic growth prospects. Based on these results, the study proposed policy recommendations aimed at mitigating the negative consequences of rapidly increasing population on economic growth. Specifically, the government was advised to prioritize family planning programs as a means to address the challenges posed by population growth. By implementing effective family planning initiatives, Bangladesh could potentially curb population growth rates, thereby alleviating the strain on economic resources and fostering sustainable economic development. By highlighting the negative correlation between population growth and economic performance, the study underscores the importance of proactive policy interventions to manage population growth effectively and sustain economic progress.

The study conducted by Chang et al. (2014) delved into the relationship between population growth and economic growth across 21 countries. Utilizing the Bootstrap Panel Granger Causality Test, the research aimed to ascertain the impact of population dynamics on economic performance. Time series data spanning from 1871 to 2013 were analyzed to understand the trends and interactions between these variables. The findings of the study suggested that population growth tends to have a negative impact on economic growth. This highlights the significance of addressing rapid population growth as a serious economic concern. To mitigate the adverse effects of population growth, the study recommended investing in family planning services. Additionally, promoting media freedom and liberal education could encourage smaller family sizes over time. Furthermore, the study underscored the role of technological development in mitigating the negative effects of population growth. By enhancing labor productivity, per capita income, and living standards, technological advancements can offset the challenges posed by population growth.

The research by Alemu et al. (2014) focused specifically on the relationship between population growth and economic growth in Mexico. Employing cointegration analysis and Granger causality tests, the study examined the dynamics between these variables using time series data spanning from 1960 to 2014. In the short run, the study found that economic growth had a negative effect on population growth. However, in the long run, a positive relationship was observed between population growth and per capita GDP, indicating that population dynamics can influence economic performance positively over time. The Granger causality test further confirmed the bidirectional relationship between population and per capita GDP, suggesting a mutual influence between these variables. The study conducted by Ali et al. (2013) focused on exploring the relationship between population growth and economic growth in Pakistan. Contrary to some views, the research findings suggested that population growth actually has a positive impact on economic growth in Pakistan. The study argued that a high number of labor force resulting from population growth stimulates economic growth by increasing productivity and contributing to various sectors of the economy. Utilizing thirty-four years of annual data, the research employed the ARDL co-integration technique to analyze the relationship between population growth and economic growth. The findings underscored the importance of addressing unemployment and implementing human resource development policies to capitalize on the potential benefits of population growth. By promoting economic growth and reducing unemployment through effective policies, the study suggested that the issue of population growth could be naturally mitigated. On the other hand, Almadi et al. (2013) investigated the impacts of population growth and its relationship with economic growth in Kenya. Their study suggested that rapid population growth in Kenya actually yields positive effects on economic development. Analyzing both short and long-term time periods, the research found that the influence of population growth on economic development in Kenya was consistently positive and robust. These findings imply that in the case of Kenya, population growth contributes to economic growth by providing a larger labor force and stimulating demand for goods and services. By harnessing the benefits of population growth, policymakers in Kenya can develop strategies to further enhance economic development and improve living standards for the population.

The study conducted by Manan et al. (2013) delved into the complex relationship between population dynamics, domestic saving, literacy, and various socioeconomic indicators in Pakistan. The research revealed that domestic saving and literacy exhibit a long-run relationship with population, while factors such as foreign direct investment (FDI) and unemployment do not. Analyzing the data, the study found that population and literacy had a negative effect on socioeconomic indicators, indicating that higher population and literacy rates were associated with adverse outcomes in certain areas. Specifically, population was found to be positively related to unemployment and FDI in Pakistan, suggesting that a larger population may lead to increased unemployment rates while attracting more foreign investment. The research identified several underlying reasons for the observed lower growth and socioeconomic challenges, including lack of awareness, scarcity of resources, gender discrimination, and government mismanagement. These factors contribute to the complexities of the population-economy nexus in Pakistan. In light of these findings, the study proposed interventions aimed at addressing these challenges and promoting sustainable socioeconomic development. One key recommendation is to provide information and raise awareness about population-related issues and their implications for social and economic phenomena among the population. By increasing awareness and understanding, policymakers and stakeholders can foster informed decision-making and implement targeted strategies to address the root causes of lower growth and socioeconomic disparities in Pakistan.

The study conducted by Mamingi et al. (2013) focused on Barbados, a small developing country, and explored the relationship between population growth and economic development over the period 1980-2010. The research findings indicated that population growth had a positive and significant effect on economic growth in Barbados. Additionally, the study highlighted the impact of various factors on economic growth, including government consumption expenditure, personal consumption, and domestic investment. It was observed that government consumption expenditure negatively and significantly influenced economic growth, while personal consumption also had a

negative impact. Conversely, domestic investment was found to have a positive and significant effect on economic growth. Furthermore, the study suggested that the level of risk in the country influenced the magnitude of economic growth, with less risky countries experiencing greater growth. Dao (2012) conducted a study examining the correlation between population dynamics and economic growth in developing nations, utilizing data from a sample of forty-three such countries. The research concluded that population growth exerted a negative influence on per capita gross domestic product (GDP) within underdeveloped nations. Moreover, the study identified that the old dependency ratio, representing the proportion of elderly individuals within the population, negatively impacted economic growth, whereas the young dependency ratio, reflecting the proportion of young individuals, had a positive effect on economic growth in developing countries. In contrast, Adewole (2012) investigated the implications of population growth on economic development specifically within Nigeria, employing the ordinary least squares method for analysis. The findings of the study suggested that governments should empower both women and men with the necessary resources and knowledge to make informed decisions regarding family planning. Encouraging responsible parenthood through such measures could potentially support economic development initiatives and contribute to the promotion of sustainable population growth within the Nigerian context.

Atanda et al. (2012) conducted a study investigating the relationship between population growth and economic development in both developed and developing countries. The research concluded that the impact of high population growth on economic growth is positive in developed countries, whereas in developing countries, the impact is negative. The study further suggested that developing countries should focus on increasing the aggregate level of investment and providing education and healthcare facilities to their population in order to achieve higher levels of economic growth. By addressing these factors, developing nations can potentially mitigate the adverse effects of high population growth and foster sustainable economic development. Jaffri et al. (2012) conducted a study to explore the impact of population growth on the current account balance of Pakistan. The research findings indicated that population growth negatively affects the current account balance and GDP in the long run. As a result, the study suggested that provincial governments should prioritize efforts to reduce Pakistan's Total Fertility Rate (TFR) from 3.5 births per woman to meet regional targets. Additionally, the study recommended increasing female labor force participation through initiatives such as skill enhancement programs, financial empowerment, and promoting social acceptability for female workers. These measures aim to address the negative economic impact of population growth and promote sustainable development in Pakistan.

Abiodun and Iyiola's (2011) investigation into the impacts of education on economic growth in Nigeria sheds light on the crucial role education plays in driving economic development. By employing the Ordinary Least Squares method, the study was able to analyze the relationship between education and economic growth empirically. The findings of the study underscored the direct positive impact of education on Nigeria's economic growth trajectory. This implies that investments in education, both in terms of infrastructure and human capital development, can yield significant dividends for the economy. A well-educated workforce is better equipped to contribute to productivity, innovation, and overall economic output. Given the significance of education for economic growth, the study's recommendations hold particular importance for policymakers. By increasing the level of education and investing more resources in educational programs, governments can foster an environment conducive to sustainable economic development. This entails initiatives to improve access to education, enhance the quality of educational institutions, and promote lifelong learning opportunities. Furthermore, the study highlights the need for strategic planning and resource allocation in the education sector. Adequate funding for education is essential to address infrastructure gaps, hire qualified educators, and provide necessary learning materials. Additionally, policies aimed at promoting inclusivity and addressing disparities in access to education can ensure that all segments of society benefit from educational opportunities.

Schramm's (2011) examination of China's family planning policies, particularly the One-Child Policy, provides valuable insights into their impact on economic growth. By utilizing time series data spanning from 1979 to 2005 and employing the Solow model, Schramm aimed to elucidate the effects of these policies on China's economic development. The findings of the study indicate that the One-Child Policy had a profound influence on China's economic trajectory over the past three decades. Initially, the policy was associated with positive economic outcomes, presumably due to a reduction in population growth and associated resource pressures. However, Schramm's analysis reveals a shift over time, with the policy ultimately exerting a negative impact on economic growth. This change in the policy's impact can be attributed to demographic dynamics, wherein an aging population and skewed sex ratios pose challenges to economic productivity and sustainability. Consequently, China now faces the prospect of a demographic dividend turning into a demographic burden, wherein the shrinking labor force and increasing elderly dependency ratios impede economic growth prospects.

Furuoka's (2010) analysis of the relationship between population and economic growth in the Philippines offers valuable insights into the long-term equilibrium dynamics between these variables. By utilizing time series data spanning from 1950 to 2007 and employing multiple tests including the ADF unit root test, Johansen Co-integration test, and Granger Causality test, Furuoka sought to discern the nature of this relationship. The study's findings reveal the existence of a long-term equilibrium relationship between population and economic growth in the Philippines. The ADF unit root test confirms the presence of a relationship between population and GDP per capita, while the Granger Causality test suggests that economic development positively influences population growth in the Philippines. Furuoka's conclusions underscore the positive association between population and economic growth in the Philippines, suggesting that population growth can contribute to economic development in certain contexts. However, further research and analysis are warranted to comprehensively understand the nuances of this relationship and its implications for economic policy and planning in the Philippines. Afzal (2009) conducted a study on the impacts of population growth on economic growth in Pakistan. His research revealed a negative relationship between population growth and economic growth in the country. He found that the rapid increase in population hindered investment and savings rates, posing challenges to economic development. Afzal highlighted the alarming position of population growth in Pakistan and recommended measures such as family planning initiatives, educational programs, and independent media campaigns to address the issue. These interventions aimed to reduce the population growth rate and promote the ideal of smaller families in Pakistan.

Ozgur et al (2009) investigated the relationship between population and per capita economic growth in Turkey. Employing the ARDL approach to Cointegration and utilizing time series data from 1924 to 2006, their analysis indicated a long-run relationship between per capita income and population. The study found a strong and positive relationship between population and economic growth in Turkey over the analyzed period. This suggests that despite efforts to control population growth through various measures, such as government policies, population dynamics in Turkey continue to respond to factors beyond direct control. Klasen et al. (2007) conducted a study to examine the

relationship between population, economic growth, and poverty in Uganda. Their research utilized both cross-sectional and panel data to assess the impact of population on economic growth and poverty reduction. By employing models such as the Harrod-Domer model and Solow model, they analyzed the effects of population growth on economic growth and per capita economic growth. The study found a positive impact of population growth on overall economic growth, but it also revealed a negative impact of population growth on per capita economic growth. Economic growth was used as the dependent variable, while population, poverty, and household size were considered as independent variables. The findings of the study suggested several policy recommendations to address the situation in Uganda. These recommendations included efforts to reduce the fertility rate and improve the education and health sectors in the country. By implementing measures to control population growth and investing in human capital development, Uganda could work towards achieving sustainable economic growth and poverty reduction.

Mushtaq (2006) investigated the relationship between population growth and per capita income over a long period in Pakistan. Using data spanning from 1960 to 2001, he conducted co-integration analyses, unit root tests, and Augmented Dickey Fuller tests. The study focused on two variables: population and per capita income. Contrary to expectations, the findings indicated that population growth did not significantly influence per capita income in the long run. Mushtaq concluded that there was no discernible relationship between population growth and income over the extended period studied. Thus, he suggested that population growth may not necessarily be a significant determinant of long-term economic outcomes in Pakistan. Albatel (2005) investigated the impact of population growth on economic development in Saudi Arabia. The study highlighted that the rapid increase in population negatively affected both savings and economic growth in the country. This surge in population was attributed to factors such as increased fertility rates and longer life expectancies. Using time series data from 1964 to 2000, Albatel employed stationarity tests and multivariate co-integration tests to analyze the relationship between population growth and economic variables. The study considered financial savings and total savings as dependent variables, while total investment, population, and savings served as independent variables. The findings suggested that reducing population growth could potentially increase the savings rate and, consequently, boost per capita income growth. Albatel recommended the implementation of policies aimed at reducing fertility rates and enhancing the productivity of the population to spur economic growth. Moreover, he proposed that population growth might stimulate innovation in technology, thereby contributing to economic advancement. Alam et al. (2003) conducted an analysis on the dynamics between fertility, family planning programs, and female schooling in Pakistan spanning from 1965 to 1998. Their findings aligned with theoretical assertions indicating that while in the long run, fertility decline may stem from intricate interactions with planned family planning and significant socio-economic structural changes. Another study focusing on the economy of Ghana revealed contrasting results, indicating that population growth had a negative impact on four key variables: education, health, environment, and the economic sector. This suggests that population dynamics can have varied effects on different aspects of a country's socio-economic landscape, emphasizing the importance of context-specific analyses when studying population dynamics and their impacts.

3. MODEL SPECIFICATION

The specific form of our model is

$$Y_g = \alpha_\circ + \alpha_1 pop + \alpha_2 FRT + \alpha_3 EDU_{\exp} + \alpha_4 EMP + \alpha_5 INV + \mu$$

- Y= Growth rate
- Pop= Population rate
- Frt= Fertility rate
- Eduexp= Education expenditure
- EMP= Employment rate
- Inv = Investment rate
- μ = error term

In this study, time series data spanning from 1981 to 2010 was utilized to assess the stationarity of the variables. Unit root tests were employed to determine the order of integration, a crucial step in analyzing time series data for trends and structural breaks. One of the primary tests used for this purpose is the Augmented Dickey-Fuller (ADF) test, which is capable of detecting trends and structural breaks in the data. The ADF test was applied to both the level and first difference of the variables. The variables included economic growth as the dependent variable, while population, fertility rate, employment, education, and investment served as independent variables. The results of each variable were assessed using the ADF test, comparing the computed test statistic with critical values at significance levels of 1%, 5%, and 10%. This test is essential for determining the stationarity of the variables and identifying trends and fluctuations within the data. By examining the ADF test results, researchers can gain insights into the underlying dynamics of the variables and their relationships over time.

4. EMPIRICAL RESULTS

Table 1 presents the descriptive results for six key macroeconomic and social variables: gross domestic product (GDP growth rate), population growth (POP), fertility rate (FRT), education attainment (EDU), employment rate (EMP), and investment as a percentage of GDP (INV). These statistics provide an overview of the central tendencies, dispersion, and distributional properties of the dataset. The average GDP growth rate is 4.714%, with a standard deviation of 2.0027, indicating moderate variability in economic performance. The values range from a minimum of 0.844% to a maximum of 7.99%. The skewness is slightly negative (–0.1297), suggesting a slight tilt toward higher growth rates, and the kurtosis is 2.2141, indicating a distribution that is somewhat flatter than a normal distribution. The Jarque-Bera test for normality gives a statistic of 1.0948 with a p-value of 0.7202, suggesting that GDP growth is normally distributed. Population growth (POP) has a mean of 2.377% and a relatively narrow standard deviation of 0.4778, indicating stability across the observed period. The distribution is moderately right-skewed (0.6381), and the kurtosis value of 1.8616 implies a light-tailed distribution. The Jarque-Bera statistic of 4.0222 with a p-value of 0.2082 shows no significant deviation from normality. Fertility rate (FRT) has a mean of 5.044 and a standard deviation of 1.0302, with values ranging between 3.37 and 6.52. The distribution is nearly symmetrical (skewness –0.0705),

and with a kurtosis of 1.5230, it shows a broader, flatter distribution compared to normal. The Jarque-Bera test also supports normality with a p-value of 0.1825. The average value of education attainment (EDU) is 2.617, with a low standard deviation of 0.2395, indicating very little variation in educational outcomes across the sample. The skewness is slightly negative (–0.3199), and kurtosis is 2.3973. The Jarque-Bera test statistic is 0.8459 with a high p-value of 0.7782, confirming normal distribution. Employment rate (EMP) shows a mean of 37.53% with a standard deviation of 3.5349. The minimum and maximum values range from 29.58% to 42.22%, which indicates a substantial range in employment levels. The skewness is negative (–0.5813), and the kurtosis is 2.6926, close to the normal threshold. The Jarque-Bera test yields a value of 2.1480 and a p-value of 0.1413, suggesting approximate normality. Investment as a percentage of GDP (INV) averages 17.636%, with a standard deviation of 1.8096. It ranges from 14.02% to 21.01%, showing moderate variation. The skewness is moderately negative (–0.6183), and the kurtosis value is 2.5892. The Jarque-Bera test, with a statistic of 2.0951 and a p-value of 0.2641, also supports the assumption of normality. The descriptive statistics indicate that all variables in the dataset are approximately normally distributed, as confirmed by the Jarque-Bera test results. The data demonstrate reasonable dispersion and variation, with most distributions showing minimal skewness and kurtosis close to 3, thereby supporting their suitability for regression-based econometric analysis.

Table 1: Descriptive Results

	GDP	POP	FRT	EDU	EMP	INV
Mean	4.71406	2.37701	5.04398	2.61715	37.52855	17.63624
Median	4.70325	2.56558	4.7601	2.46544	37.68341	17.90221
Maximum	7.98982	3.34001	6.52085	2.92462	42.22098	21.00729
Minimum	0.84404	1.93033	3.36566	1.81413	29.58264	14.01961
Std. Dev.	2.00267	0.47777	1.03023	0.23949	3.53486	1.80956
Skewness	-0.12966	0.6381	-0.07049	-0.31994	-0.58129	-0.6183
Kurtosis	2.2141	1.86163	1.52303	2.39731	2.69261	2.58918
Jarque-Bera	1.09481	4.02216	3.54041	0.8459	2.14804	2.0951
Probability	0.72023	0.20824	0.18254	0.77821	0.14125	0.26408
Sum	165.634	88.22427	174.7682	86.53638	1317.847	621.2793
Sum Sq. Dev.	133.0675	7.95135	38.80907	3.34925	389.2781	92.8898

Table 2 reports the results of the Augmented Dickey-Fuller (ADF) unit root test conducted to determine the stationarity properties of the variables under study, both at level and at first difference, using models with and without trend components. The primary purpose of the test is to identify the order of integration—whether a variable is stationary at level, denoted I(0), or becomes stationary only after first differencing, denoted I(1). The GDP growth rate (GDPg) is found to be stationary at level, as indicated by high test statistics under both the intercept (3.2042) and trend-intercept models (3.6489). Its values at first difference are even higher (7.9535 and 7.1724), confirming stationarity. Based on these results, GDPg is classified as I(0), meaning it is stationary in its original form and does not require differencing for further analysis. Population growth (POP) is non-stationary at level with test statistics of 4.0442 and 4.3761 under the intercept and trend-intercept models, respectively. However, it becomes stationary after first differencing, as shown by values of 4.3986 and 4.3961. Therefore, population growth is integrated of order one, I(1). The fertility rate (FRT) also displays non-stationarity at level (1.8229 under intercept and –2.8451 under trend-intercept), but achieves stationarity at the first difference stage, especially with a strongly negative value (–7.1184) under the trend-intercept specification. Thus, fertility rate is confirmed as I(1). Education expenditure (EDUexp) is stationary at level, with test statistics of –3.7459 and –3.7287 that exceed typical critical thresholds under both intercept-only and trend-intercept models. The values at first difference are even stronger. Hence, EDUexp is stationary in level, I(0). The employment rate (EMP) does not show stationarity at level (–2.1466 and –2.0594), but after first differencing, the test statistics improve significantly (–3.2181 and –3.6212), suggesting that employment becomes stationary at the first difference. It is therefore classified as I(1). Finally, investment as a percentage of GDP (INV) is non-stationary at level with statistics of 1.8519 and 2.7721, but becomes stationary after first differencing, as reflected in high test values of 5.9165 and 5.7515. This confirms that investment is also integrated of order one, I(1). The variables GDP growth and education expenditure are stationary at level (I(0)), while population growth, fertility rate, employment rate, and investment are stationary only after first differencing (I(1)). This mix of integration orders suggests that ARDL (Autoregressive Distributed Lag) modeling is appropriate, as it allows for the combination of I(0) and I(1) variables in the same regression framework.

Table 3 presents the results of the ARDL Bounds Test conducted to examine the existence of a long-run relationship between economic growth and its associated explanatory variables. The dependent variable is economic growth, and the test evaluates whether a stable, cointegrated relationship exists among the variables in the model. The calculated F-statistic is 27.8817, with K = 5, indicating the number of explanatory variables included in the model. This F-statistic is then compared with the critical values for the lower bound (I0) and upper bound (I1) at various significance levels. At the 10% significance level, the critical bounds are 2.26 (I0) and 3.35 (I1); at 5%, the bounds are 2.62 and 3.79; at 2.5%, they are 2.96 and 4.18; and at the 1% level, the bounds are 3.41 and 4.68. The calculated F-statistic of 27.8817 is well above the upper bounds at all significance levels, including the most stringent 1% level. This result strongly suggests that the null hypothesis of no long-run relationship can be rejected with high confidence. Therefore, there is compelling evidence of a stable long-run cointegrating relationship between economic growth and the included explanatory variables. This validates the use of the ARDL model for long-run and short-run dynamics analysis and supports the conclusion that economic growth is significantly influenced by the underlying regressors over the long term.

Table 2: Augmented Dickey Fuller (ADF) Unit root

Variable	Level Intercept	Level Trend Intercept	First Diff Intercept	First Diff Trend Intercept	Order of Integration
GDPg	3.204219	3.648979	7.953502	7.172411	I(0)
POP	4.044247	4.376063	4.398557	4.396102	I(1)
FRT	1.822906	-2.84509	0.250323	-7.11836	I(1)
EDUexp	-3.74589	-3.72872	-5.12459	-5.24878	I(0)
EMP	-2.14661	-2.05943	-3.21813	-3.62116	I(1)
INV	1.851875	2.772106	5.916491	5.751494	I(1)

Table 3: Bound Test F-statistics value

Dependent Variable: Economic Growth

Test Statistic		Value	K
F-statistic		27.88174	5
Critical Value Bounds			
Significance		I0 Bound	I1 Bound
	10%	2.26	3.35
	5%	2.62	3.79
	2.5%	2.96	4.18
	1%	3.41	4.68

The long-run results of the Autoregressive Distributed Lag (ARDL) model presented in Table 4 provide a comprehensive understanding of the key determinants of economic growth in the context of the given variables: investment rate, employment rate, fertility rate, education expenditure, and population rate. The empirical findings reveal that most of the explanatory variables included in the model exhibit statistically significant relationships with economic growth, with implications consistent with both theoretical expectations and prior empirical studies. The investment rate (INV) displays a positive and statistically significant impact on economic growth in the long run, with a coefficient of 3.051057 and a p-value of 0.0391. This indicates that a 1% increase in the investment rate leads to an approximate 3.05% rise in economic growth, holding other factors constant. The strength and significance of this relationship align with classical and neoclassical economic theories that emphasize the vital role of capital accumulation in stimulating productive capacity and output (Solow, 1956; Mankiw, Romer, & Weil, 1992). Investment enhances infrastructure, technology adoption, and industrial expansion, all of which serve as drivers of long-term economic performance. Similarly, the employment rate (EMPLOY) also has a positive and statistically significant effect on economic growth. The coefficient value of 1.483386 and a p-value of 0.0255 imply that increased labor participation directly contributes to higher output. This result is consistent with the findings of empirical literature which highlight that labor is one of the critical inputs in the production function, and higher employment facilitates more efficient utilization of resources and promotes household income generation (Blanchard & Katz, 1999). Employment, particularly in sectors with high productivity, can stimulate demand, enhance consumption, and reinforce a virtuous cycle of economic expansion.

Conversely, the fertility rate (FRT) is found to have a negative and statistically significant relationship with economic growth, with a large negative coefficient of -28.878 and a p-value of 0.0369. This suggests that a higher fertility rate poses a drag on economic growth, which aligns with the demographic transition theory and the empirical works of Barro and Becker (1989). High fertility often translates into higher dependency ratios, increased pressure on social services, and limited investment in human capital per child. In countries experiencing rapid population growth due to high fertility, scarce resources are diluted across larger populations, reducing per capita availability and potentially stalling economic progress. The education expenditure (EDU), represented by public spending on education, presents a positive coefficient of 0.209826; however, this variable is statistically insignificant with a p-value of 0.779. This finding, while counterintuitive, is not uncommon in the empirical literature from developing countries. Several studies have noted that the effectiveness of education expenditure depends not only on the amount of spending but also on its efficiency, targeting, and alignment with labor market demands (Hanushek & Kimko, 2000). In contexts where education quality is low, curricula are outdated, or governance is weak, the impact of education spending on economic growth may be negligible in the short to medium term. The population rate (POP) shows a strong and statistically significant positive effect on economic growth, with a coefficient of 69.19106 and a p-value of 0.0319. This result may initially appear contradictory to the negative effect of the fertility rate, but the distinction lies in the interpretation of these variables. While high fertility increases the number of dependents, a growing working-age population, when accompanied by employment and skill development, can lead to a demographic dividend. This is supported by studies such as Bloom, Canning, and Sevilla (2003), who argued that a balanced population structure with a large proportion of productive individuals can significantly boost economic performance, provided there are appropriate employment and investment opportunities. The constant term (C) in the model is negative and significant, suggesting that in the absence of changes in the included variables, the baseline level of economic growth would be negative. This implies that proactive investment, labor absorption, population management, and fertility control are essential for sustained economic advancement. The long-run ARDL results indicate that investment and employment rates are key positive determinants of economic growth, while a high fertility rate has a detrimental effect. The insignificance of education expenditure suggests the need for policy reforms focusing on quality and effectiveness rather than merely increasing budgetary allocations. Meanwhile, a rising population, if managed effectively through skill development and employment generation, may contribute positively to growth. These findings underscore the importance of integrated policy approaches that align demographic trends, labor market dynamics, and capital investment to foster long-run economic development.

Table 4: ARDL Model Long-run Results
Dependent Variable: Economic Growth

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INV	3.051057	0.599404	5.090147	0.0391
EMPLOY	1.483386	0.285009	5.204707	0.0255
FRT	-28.878	5.822751	-4.95952	0.0369
EDU	0.209826	0.491286	0.427096	0.779
POP	69.19106	12.7352	5.433059	0.0319
C	-136.805	23.19606	-5.89777	0.0275

The short-run dynamics of economic growth, as revealed by the Autoregressive Distributed Lag (ARDL) model in Table 5, demonstrate several important insights about the behavior of key macroeconomic variables in relation to economic performance in the immediate term. These relationships, although consistent in direction with many long-run expectations, differ in terms of statistical significance and magnitude, thereby reflecting the transitional adjustments economies undergo before long-run equilibrium is achieved. The lagged dependent variable has a highly significant and positive coefficient of 3.734015, with a t-statistic of 7.147679 and a p-value of 0.019. This coefficient indicates that economic growth in the previous period has a strong and positive influence on current growth. This form of positive autocorrelation suggests persistence in growth patterns, which is a common feature in time-series data and confirms the inertia within the economic system, as documented in earlier empirical studies (Barro & Sala-i-Martin, 1995). Investment in the short run remains positively associated with economic growth, with a coefficient of 3.213904 and a p-value of 0.0473, indicating statistical significance at the 5% level. This finding affirms the Keynesian perspective, where increased investment leads to immediate increases in aggregate demand and, consequently, national output. Such short-term stimulus effects of investment are crucial for economies aiming to jumpstart growth following slowdowns (Blejer & Khan, 1984).

Table 5: Short Run Results
Dependent Variable: Economic Growth

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDPG(-1))	3.734015	0.52592	7.147679	0.019
D(INV)	3.213904	0.714708	4.431885	0.0473
D(EMPLOY)	3.633068	0.966544	3.830007	0.0619
D(FRT)	12.81107	7.138222	1.791882	0.215
D(EDU)	11.15859	3.023833	3.668226	0.0669
D(POP)	-103.08	38.59592	-2.66909	0.1164
CointEq(-1)	-6.1188	0.645574	-9.48575	0.0109

The employment variable also has a strong and positive coefficient of 3.633068, though its p-value of 0.0619 places it just above conventional levels of statistical significance. Nonetheless, this near-significant result implies that increases in employment likely contribute positively to economic performance in the short term. As employment rises, household incomes increase, fueling consumption, which is a major component of gross domestic product. These findings are consistent with the multiplier effect articulated in macroeconomic theory and align with empirical work on labor markets and growth (Okun, 1962). In contrast, the short-run coefficient of fertility rate is positive at 12.81107 but statistically insignificant with a p-value of 0.215. This result diverges from the long-run negative impact observed previously and may reflect transitional dynamics. For instance, higher fertility might temporarily increase consumption demand, especially in developing contexts with high marginal propensity to consume, but the long-term strain on resources and productivity eventually turns this impact negative. This distinction underscores the complexity of demographic variables in growth analysis (Kelley & Schmidt, 2005). Education expenditure also shows a large positive coefficient of 11.15859 with a t-statistic of 3.668226 and a p-value of 0.0669. Although not significant at the 5% level, this result is noteworthy. It suggests that in the short run, increases in education-related spending can stimulate economic activity, possibly through employment of teachers, infrastructure development, and increased household expenditures on education-related goods. However, such immediate returns are often modest, as education tends to exhibit lagged benefits through human capital accumulation (Psacharopoulos & Patrinos, 2004). On the other hand, the population growth variable shows a large negative coefficient of -103.08, though its p-value of 0.1164 renders it statistically insignificant. This suggests that, in the short term, rapid population growth may act as a drag on economic performance, perhaps due to increased burdens on public services, infrastructure, and labor markets. This aligns with the Malthusian interpretation, where rapid population increases strain existing resources and capital (Birdsall, 1988). Perhaps the most critical statistic in the short-run model is the coefficient of the error correction term, which is negative and statistically significant at the 1% level with a coefficient of -6.1188 and a p-value of 0.0109. This term represents the speed of adjustment towards long-run equilibrium following a short-run shock. The high magnitude and significance of this coefficient indicate that approximately 611% of disequilibrium is corrected in each period, reflecting a very strong pull back to equilibrium. This rapid convergence highlights that while short-term fluctuations occur, the economy exhibits a robust mechanism for re-aligning to its long-run growth path. Such strong correction speeds are rare and may also reflect structural rigidity or policy-driven adjustments in macroeconomic frameworks. The short-run results

emphasize the immediate responsiveness of economic growth to investment and employment increases, while fertility and population have ambiguous short-run effects that are more clearly negative in the long run. Education spending, while not yet statistically significant in this model, hints at a positive short-term role in stimulating economic activity. Most notably, the error correction term signals that short-run deviations from equilibrium are rapidly corrected, ensuring stability in the overall economic growth trajectory. These findings underscore the need for balanced and timely policy interventions that address both short-term economic volatility and long-term structural transformation.

5. CONCLUSIONS

The findings of the study highlight the significant impact of population dynamics on economic growth in Pakistan. With a population of 191.71 million people and continuing growth, Pakistan faces considerable challenges in sustaining economic development. The study revealed that despite the population's alarming stage, there remains a lack of awareness among the general populace regarding the adverse effects of population growth on economic prosperity. By employing economic growth as the dependent variable and population, investment, fertility rate, and employment as independent variables, the study aimed to elucidate the intricate relationship between these factors. Using time series data spanning from 1981 to 2015, encompassing 35 years, the study applied various econometric techniques to analyze the data. The unit root test, specifically the Augmented Dickey-Fuller (ADF) test, indicated a mix of integration orders, with some variables exhibiting stationary behavior (I(0)) and others displaying non-stationarity (I(1)). Subsequently, the study applied the autoregressive distributed lag (ARDL) test to explore the relationships between the variables and their lag values. The results largely supported the study's hypotheses. Notably, the study found that population growth had a negative impact on economic growth, reinforcing the notion that the burgeoning population poses significant challenges to Pakistan's economic development. Furthermore, fertility rates were also found to have adverse effects on economic growth in recent years. On the other hand, investment and employment were identified as positive drivers of economic growth, indicating their importance in stimulating economic activity and development. The study's findings strongly support the hypothesized relationship between population dynamics and economic growth, indicating a significant hindrance posed by population growth to Pakistan's economic development. The model results demonstrate a good fit, further reinforcing the validity of the study's conclusions. The situation of population in many developing countries, including Pakistan, has become increasingly critical in recent years, reaching an alarming level. Compounding this issue is the lack of education among the populace regarding the consequences of large family sizes and the associated costs. Unfortunately, the government of Pakistan has not implemented effective policies to address the challenges posed by overpopulation. However, the study highlights the potential for positive impact through increased investment, as evidenced by the significant coefficient of investment in the model. Higher levels of investment are shown to contribute substantially to economic growth, contingent upon a high saving rate. Achieving sustained economic growth of over 6% could help alleviate poverty, but efforts to curb population growth have thus far been unsuccessful. Addressing the population challenge requires multifaceted approaches, including promoting education and awareness, encouraging smaller family sizes, and implementing effective family planning policies. Education institutions play a crucial role in providing technical and open-minded education that empowers individuals to make informed decisions about family planning. Additionally, media can play a vital role in disseminating information about the impacts of population growth on the economy and promoting responsible family planning practices. Furthermore, government investment in population-related initiatives, such as providing basic necessities and job opportunities, can improve living standards and contribute to overall economic growth. By adopting comprehensive strategies and policies to control population growth, Pakistan can mitigate the adverse effects on economic development and pave the way for sustainable growth and prosperity.

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