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DEMOGRAPHIC DYNAMICS AND ECONOMIC GROWTH IN PAKISTAN: AN ARDL APPROACH

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Abstract
Economic growth is significant for a country's development and wealth. It leads to an improved standard of living, as high income leads to better facilities for education, healthcare, and job opportunities. The study used the time series data that starts from 1972-2023 in Pakistan. The study uses an autoregressive distributed lag model to determine the link between demographic change and growth. The study finds out that population density, ratio of labor force working-age population, and total dependency ratio have a negative relationship with GDP per capita growth. These variables have long-term negative impacts if not properly managed. Education, gross domestic savings, and life expectancy have a positive impact on growth, as higher education, life expectancy, and savings lead to higher production and investment respectively boosting the economy. Overall study concludes that the population has a great burden on the economic growth of Pakistan. If a population is not controlled, it can be very harmful to the economy so understanding economic growth and demographic factors is the key to making future plans.
Keywords: *GDP, Population Density, Labor Force, Total Dependency Ratio, Saving, Life expectancy*

INTRODUCTION

Economic growth is important for a country's development and wealth. The GDP of an economy is the increase in the capacity of a country to produce goods and services with time, showing a rise in GDP and improvement in lifestyle, as well as better facilities for education, healthcare, and job opportunities (World Bank, 2023). Economic development plays a vital role in addressing poverty due to an increase in income that leads to reduced poverty levels. Furthermore, the GDP of an economy promotes economic stability through growth in investments, innovations, and entrepreneurship. As economic growth increases, the government can invest more in healthcare facilities, education, and other innovation programs (Kuznets, 1955). Additionally, foreign investment is attracted by economic growth and increases its effect on international trade and its link with other countries. Overall, GDP growth is necessary for improving lifestyles, decreasing poverty, and promoting development, for a country's overall well-being and prosperity.

Demographic change refers to changes in the size and distribution of the population together with each other, with changes in its structure with time. The shifts can be examined by aspects of fertility and life expectancy, mortality and aging, and other dimensions that in turn affect demand in health, education, and labor (Bloom et al., 2011; Karhan, 2019; Ali & Madheswaran, 2020; Adjasi & Yu, 2021; Abigail, 2023; Xiong, 2024). Demographic change impacts the education system as an aging population needs more education for old age people, while young individuals need schools and education resources (UNESCO, 2020).

The population of the world has reached 6 billion in the 21st century and continuously increasing day by day. The population of the world increased by 75 million each year. Pakistan became the 6th most populated country in the whole world. The population of Pakistan is approximately 253 million in the following year and is projected to reach 255 million in 2025. The population has diminished slightly in 2023 and 2024 from 1.56% to 1.52%

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respectively. The overall population is 80% of the population of developed states and some parts of Asian countries. The population structure is different in developing and developed nations. The population in developed nations is measured by their improved utilization of employment. On the other hand, developing nations are affected by their high population growth rates as their basic need of resources is not properly manageable and their nations are not paying attention to their resources. GDP and population have a direct relation as high population affects economic GDP growth. In most developing nations, population growth itself is an actual problem. High labor supply that increases GDP growth followed by high population. Since freedom, Pakistan saw an increase of just one million people over a year. No progress is made, in such a situation of population growth. A high population puts the resources under pressure and increases the ratio of young people's dependency in a country. In the 1960s and 1970s, the growth in population of the country was 2.5 per annum, and high growth resulted in a decrease in the mortality rate and an increase in life expectancy (Khan, 2007; Ali & Zulfiqar, 2018; Ali & Sajid, 2020; Muhammad, 2023; Ali & Mohsin, 2023). An increase in GDP has a major implication for a country's economy. A high population leads to a boost in GDP growth and development in economies, as population growth puts pressure on the resources of the country and infrastructure and delays growth (Bloom, 2011). The population impact on economic growth has analyzed the negative effect of population on GDP which contains data by countries and results show that population has a negative relationship with growth (Afzal, 2009; Ahmad, 2018; Farahmand, 2019; Modibbo & Inuwa, 2020; Chen, 2022; Sadashiv, 2023). The connection between population and per capita income in the long run reveals that growth doesn't affect in the long run (Mushtaq, 2006; Ali & Rehman, 2015; Avelion & Coronel, 2021; Sossounoy & Kolenikov, 2023). The link between demographic transformation and economic development also contributed to the creation of a policy environment that maximizes the country's potential and has a positive relationship with each other (Hussain et al., 2009; Safdar & Malik, 2020; Kilyachkov & Chaldaeya, 2021; Osei & Acheampong, 2021; Pacillo, 2022; Dahmani & Makram, 2024). The effect of population on growth shows that population and crude death rate had a favorable effect on GDP growth in both the long run and short run. Fertility also had a detrimental effect on economic growth in both short and long-run periods (Khan, 2018; Yan & Chen, 2019; Zhan, 2020; Jan et al., 2021). The link between demographic dividend and economic characteristics with internet use and resulted that, after controlling demographical dividend types, internet use an increase in a country was also linked to improved access to energy better economic growth decreased inflation, and more FDI inflows (Labeeyue & Sanaullah, 2019; Fatima & Zaman, 2020; Rajagukguk, 2022; Radas, 2023; Audi, 2024). This theory meaningfully sums up the present literature by giving a better understanding of several demographical aspects and their economic implication by showing changes in demographic trends in Pakistan that are endured. This study is useful for both government and non-governmental institutions, worried about controlling the growth of the population, implementing plans, and getting useful results. The other aspect of the theory is that by this public will be aware of the paths in which the population is decreasing. Beneficial population growth also results in the decline of employment. This study investigated demographic changes and economic growth for periods starting from 1973 and ending in 2023. The population study has a vast scope in the world. The study mainly focuses on population and a little bit of discussion on other dimensions of the population that affect the economic development of Pakistan. The ARDL methodology was used in this study and found mixed results.

The study contains six sections in the following order. Section 2 evaluates the summary of the previous literature. The model specification, data sources, and methodology are explained in Section 3. Section 4 explains the empirical analysis, estimations, interpretations, and a detailed discussion of the results of variables. Chapter 5 concludes and provides implications based on the literature of the study.

REVIEW OF LITERATURE

Table 1 consists of studies on demographic changes and economic growth along with research gaps.

Table 1: Studies on Demographic Change and Economic Growth

Reference(s)	Time Period	Country	Methodology	Main Findings
Bloom et al. (1999)	1965-1990	Asian countries (70)	OlS	The outcomes showed that population had minimal effect on growth.

Hondroyiannis & Papapetrou (2004)	1960-1998	Greece	VECM	The findings revealed that the fertility rate changes due to changes in infant mortality and growth.
Jalil et al. (2008)	1960-2005	China, Pakistan	ARDL model	The consequences presented that DPR and CPS positive impact on growth in Pakistan, CPS had a minor and DPR had no effect in China.
Malmberg et al. (2009)	1750-2050	Sweden	OLS	The population had a negative impact on development but WAP had a positive impact.
Bloom et al. (2009)	1960-2005	Asia	OLS	The output showed that IMR, TRR, WR, PG, and GL had a positive effect on growth.
Hussain et al. (2009)	1972-2006	Pakistan	OLS	The results showed that a fall in infant mortality and TF had a positive impact on growth.
Afzal (2009)	1950-2001 1981-2005	Pakistan	OLS	The conclusion outlined that high PG had a negative impact on GDP by declining I, FI, and EX.
Lee et al. (2010)	1960-2000	19 countries	OLG	The results showed that low TFR had a positive impact on C and HCA and while negative on GDP.
Wei et al. (2010)	1989-2004	China	OLS	The reports showed that demographic change had a positive impact on economic growth by WAP, to boost the economy.
Lewis et al. (2010)	1960-2007	Indonesia	VEC	The evidence clarified that urbanization had a positive impact on growth.
Bloom et al. (2010)	1965-2010	Nigeria	OLS	The GDP was increased by an increase in investment and by declining fertility rates.
Chaudhary et al. (2010)	1961-2003	Pakistan China India	OLS	The result showed the positive effect of growth with WAP.
Cervallati & Sunde (2011)	1940-2000	47 countries	OLS	The data showed that high LE and GDP positively impact human capital and income.
Mulok et al. (2011)	1960-2009	Malaysia	VAR model	The implications revealed no connection between PG and GDP.
Fisker & Simenson (2012)	1973-2007	Indonesia	OLS, GMM	The results identified a negative effect of earthquakes on growth.
Dao (2012)	1990-2008	Developing countries	Least Squares Method	The outcomes examined low PG and high YDR had a positive impact on growth.
Adedokun & Olayiwola (2012)	1980-2019	Nigeria	ARDL model	The conclusion examined BR, LE, and FL had positive, and dependency and death rates had negative effects on growth.
Yao et al. (2013)	1952-2008	China	VECM model	The result showed a negative effect of population on growth.
Liu et al. (2013)	1983-2008	China	OLS	The result identified a negative effect of population on growth.

Ali et al. (2013)	1975-2008	Pakistan	ARDL	The findings showed that population was positively related to growth.
Song (2013)	1965-2009	13 Asian countries	OLS	The results showed that the population had a negative on growth.
Haruyama et al. (2013)	1970-2004	G7 countries	OLS	The data discovered that high BR and LE had a positive effect on growth.
Iqbal et al. (2015)	1974-2011	Pakistan	ARDL model	The demographic change had a positive effect on growth in the long run and a negative effect in the short run.
Ranganathan et al. (2015)	More than 50 years	200 countries	OLS	The results showed that low CMR and FR were more effective for GDP and development.
Arshad et al. (2016)	1991-2011	Pakistan	GMM	The results show that stable energy prices maintain growth, while change in prices has a negative impact on growth.
Ahmad et al. (2016)	1950-2010	160 countries	GMM	The conclusion showed that high WAP had a positive impact on growth.
Ahmad et al. (2016)	1981-2010	Pakistan	ARDL	The results showed that a high population had negative effects.
Adenola et al. (2017)	1994-2016	Nigeria	OLS	The output showed that LF and ER had positive, and IR had negative effects on the GDP.
Mageri et al. (2018)	1991-2014	Karnataka	ARDL	The results revealed that demographic change had a positive effect on growth in the long run and a negative in the short run.
Ogunjimi et al. (2018)	1981-2016	Nigeria	ARDL	The high-aged population had a negative and the child labor force population had a positive impact on growth.
Butt et al. (2019)	1950-2010	10 Middle East countries	OLS	The study showed that PG had a negative and LE, DR, and GDS had a positive impact on growth.
Ye et al. (2020)	1978-2015	China US	VAR	The analysis found that economic growth in China was positively affected by aging than in the US.
Bawazir et al. (2020)	1996-2016	10 middle Eastern countries	OLS	The results showed that population had a positive effect on growth.
Han & Lee (2020)	1986-2017	Korea	Quantity-Adjusted Labor model	The output showed that when the quantity of labor declines, human capital growth had a positive effect on the GDP.
Jehan & Khan (2020)	1960-2014	Pakistan	FMOLS	The results found that high age dependency had a negative impact on growth.
Muneer & Shahid (2020)	1980-2018	Bangladesh China Pakistan India	Panel ARDL	The findings showed that capital stock, FR, and LE had a positive impact on growth, and high YDR had a negative effect.

Sebikabu et al. (2020)	1974-2013	Rwanda	ARDL model	The population had a positive impact on growth.
Park et al. (2020)	1965-2014	OECD countries	OLS	The results showed that high LE and high labor productivity had a positive effect, and population aging and low WAP had a negative effect.
Kajimura (2020)	1990-2017	East and Southeast Asia	Fixed Effect model	The data showed the negative impact of an aging population and the positive effect of the labor force on the GDP.
Ahmad & Shah (2021)	1982-2017	5 Asian countries	ARDL model	The results showed that TDR and YDR had a positive impact, and ODR had a negative impact on growth.
Jain et al. (2021)	1981-2015	India	OLS	The evidence implied that IMR had a negative effect, and WPR, GDI, and log working age ratio had positive effects on growth.
Pasichnyi and Nepytaliuk (2021)	1990-2018	45 Advanced and Emerging economies	OLS	The results showed that an increase in WAP had a negative impact on growth.
Ahmad & Nayyab (2021)	1967-2017	Pakistan India Bangladesh Sri Lanka	OLS	The result showed that LE and TFR has a positive impact on growth.
Jan (2021)	1960-2020	Pakistan	ARDL model	The evidence found that population and crude death rates had a positive effect on growth both in the long and short run.
Chishti (2022)	1960-2018	Pakistan	FMOLS	The result observed that FDI, TO, HK, and WAP had positive, while PG had a negative effect on growth.
Rajagukguk (2022)	2001-2017	186 countries	2SLS model	The data showed that FDI, GDP, and access to energy had a positive impact while inflation had a negative effect on growth.
Nguea (2023)	1996-2018	32 African countries	STIRPAT model	The result showed that growth, FDI, and urbanization increase ecological footprints and reduce sustainability.
Khan et al. (2023)	1985-2022	Pakistan	OLS	The outcomes implied financial mediation and liquidity had a positive effect on growth.
Mihajlovic et al. (2024)	2000-2020	8 European Union countries	ARDL model	The result showed that a decrease in population aging, in the long run, causes GCF and S to increase in the short run.
Gbehe et al. (2024)	1992-2019	Sub-Saharan African nations	ARDL, FMOLS, DOLS technique	The output implied that demographic structure had a positive impact on growth in the long run.
Ardita & Marktanner (2024)	1972-2021	East Asia	OLS	The result showed that there is a long-term link between GDP, population, and capital stock.

Masheed et al. (2024)	1973-2002, 2002-2022	Pakistan and Afghanistan	ARDL model	The findings evaluated that fiscal deficit in both countries declines GDP growth.

The reviews use less developed countries (LDCs) and emerging economies. It also includes some developed countries (DCs). The methodology used in the review is mostly ordinary least square (OLS) methods. The results are mostly mixed and at times conflicting. Some review suggests that population growth has a negative impact on economic growth, while others demonstrate positive correlations, particularly with the working-age population. Similarly, depending on the situation, variables such as fertility rates and infant mortality can positively and negatively affect growth. Urbanization and investment yield positive impacts, but high dependency ratios and aging populations can impede growth. The discrepancies arise from different methodologies, contexts, and economic environments across various studies. Therefore, while there are common patterns, the influences of demographic factors on growth are complex and dependent on the study.

MODEL, DATA AND METHODOLOGY

MODEL SPECIFICATION

To evaluate the impact of demographic factors on economic growth in Pakistan, we have proposed the following model:

Model 1: Demographic Change and Economic Growth

The functional form of the model is mentioned as:

$$GDPPC = f(EDU, GDS, EPR, PD, RLFWA, PGR, TDR, LE) \quad (1)$$

The econometric model specification is given as:

$$GDPPC = \beta_0 + \beta_1 EDU + \beta_2 GDS + \beta_3 EPR + \beta_4 PD + \beta_5 RLFWA + \beta_6 PGR + \beta_7 TDR + \beta_8 LE + \varepsilon_i \quad (2)$$

The model analyses the factors that affect economic growth. Economic growth is the main variable of interest in this study. The GDP growth per capita is used as a dependent variable whereas, gross domestic saving (GDS), employment to population ratio (EPR), population density (PD), education (EDU), ratio of labor force working age participation ratio (RLFWA), population growth rate (PGR), and life expectancy (LE) are used as independent variables.

GDS is incorporated as a variable in the model that shows that high saving in a country leads to high investments that increase growth. EDU is also the main variable that predicts a high level of education increases human wealth, output, and GDP growth. Similarly, population density, life expectancy, and population growth show demographic transition that promotes growth with better healthcare, excessive growth, basic resources, levels of infrastructure, and urbanization.

Labor force participation and employment ratio based on production theory are also used as independent variables in the model as they are important for economic growth. Higher participants and increased labor supply lead towards high production and higher employment directly encourages economic activity and GDP per capita growth.

VARIABLES DESCRIPTION, MEASUREMENTS AND DATA SOURCES

The study used time series data from Pakistan spanning the period from 1972 to 2023. Table 2 shows the description of variables, their unit of measurement and the data sources from which data are collected.

Table 2: Variables Description, Measurement Unit and Data Sources

Variables	Description of Variables	Unit of Measurement	Data Sources
GDPPC	Gross Domestic Product Per Capita	% Annual	
PD	Population Density	Per square kilometer	
RLFWA	The ratio of Labor Force Working-age	%	

	Population as of Total Population (15-64 ages)		World Development Indicators
EPR	Employment to Population Ratio	%	
EDU	Total enrollment at the territory level	% gross	
GDS	Gross Domestic Saving	% of GDP	
PGR	Population Growth	% Annual	
TDR	Total Dependency Ratio	% of Working-age Population	
LE	Life Expectancy	Years	

METHODOLOGY

In this section, the methodology used in the study adopts the recently developed ARDL framework by Pesaran and Shin (1995, 1999), Pesaran et al. (1996), and Pesaran (1997) to create the way of interconnection between variables. The bound testing method is superior to other cointegration methods. The ARDL method employs only a single reduced form of equation in long-run relationships. This method of cointegration may be used despite the stationary level of the key variables whether they are integrated or not, or a mixture of both (Pesaran, Shin, and Smith 2001). This bound testing method, employs the general-to-specific modeling structure, by enchanting a basic number of lags. The short-run equilibrium can be integrated with the long-run equilibrium in ARDL. There is no endogeneity problem due to a suitable selection of lags in the ARDL model. The ARDL approach does not involve pre-testing variables, which means the test on the already present relationship between variables in levels is appropriate, regardless of whether the primary regressors are stationary I (0), not stationary I (1), or a mixture of both. Moreover, the ARDL method restricts the higher number of specifications made in the cointegration test. Thus, the study includes the decisions concerning a number of endogenous and exogenous variables to be included, as well as the number of optimal lags specified. The results are generally very crucial to the method and various choices are presented in the estimation process (Pesaran & Smith, 1998).

The study used a unit root test to check that there is no integration I (2) of variables. The variables in equation (3) are transformed into log-linear form. The log form represents the short-run and long-run resistance. Based on Shahbaz et al. (2012), the log version of the verified variables can produce a constant and reliable estimation. To identify the presence of a long-run relationship between variables, the study employs the ARDL method and applies the OLS method for estimation and the equation is given as:

$$\begin{aligned}\Delta \text{lnGDPPC} = {} & \alpha_0 + \sum_{i=1}^{p} \alpha_{1ik} \ln GDPPC_{t-i} + \sum_{i=0}^{p} \alpha_2 \ln PD_{t-i} + \sum_{i=0}^{p} \alpha_3 \ln LE_{t-i} + \sum_{i=0}^{p} \alpha_4 \ln TDR_{t-i} \\ & + \sum_{i=0}^{p} \alpha_5 \ln PGR_{t-i} + \sum_{i=0}^{p} \alpha_6 \ln EDU_{t-i} + \sum_{i=0}^{p} \alpha_7 \ln EPR_{t-i} + \sum_{i=0}^{p} \alpha_8 \ln RLFWA_{t-i} \\ & + \lambda_1 \ln GDPPC_{t-i} + \lambda_2 \ln PD_{t-i} + \lambda_3 \ln LE_{t-i} + \lambda_4 \ln TDR_{t-i} + \lambda_5 \ln PGR_{t-i} \\ & + \lambda_6 \ln EDU_{t-i} + \lambda_7 \ln EPR_{t-i} + \lambda_8 \ln RLFWA_{t-i} + \varepsilon_t \end{aligned}$$

(3)

In the short-run dynamics, error correction is represented by summation signs, whereas, the long-run association is observed through the F-statistic by considering the null hypothesis of no co-integration, Ho = λ1 = λ2 = λ3 = λ4 = λ5 = λ6 = λ7 = 0. Whereas, the alternative hypothesis is that all the variables are not equal to 0. According to Pesaran, Shin, and Smith (2001), in the calculation of F-statistics, there are two supposing critical values either will be stationary I (0) and non-stationary I (1). The orders of the lags in the ARDL model are selected by either the Akaike information criterion (AIC) or the Schwarz Bayesian criterion (SBC) before the selected model is estimated by ordinary least squares. After selecting the lag length, if there is a long-run relationship, then error correction is represented as:

$$\Delta \text{lnGDPPC} = \alpha_0 + \sum_{i=1}^{p} \alpha_{1ik} \ln GDPPC_{t-i} + \sum_{i=0}^{p} \alpha_2 \ln PD_{t-i} + \sum_{i=0}^{p} \alpha_3 \ln LE_{t-i} + \sum_{i=0}^{p} \alpha_4 \ln TDR_{t-i} + \sum_{i=0}^{p} \alpha_5 \ln PGR_{t-i} + \sum_{i=0}^{p} \alpha_6 \ln EDU_{t-i} + \sum_{i=0}^{p} \alpha_7 \ln EPR_{t-i} + \sum_{i=0}^{p} \alpha_8 \ln RLFWA_{t-i} + \theta ECT_{t-i} + \varepsilon_t \quad (4)$$

The error correction mechanism (ECM) is the type of time series that measures the impact of one time period on another and corrects the error in another. ECM is applied to examine the short-run dynamics of the model. The ECM determines that the change in the dependent variable is proportional to the sum of both changes in independent variables and partial correction of the degree to which the lagged dependent variable deviated from the equilibrium value corresponding to the lagged independent variable (Shittu et al, 2012). The above equation symbolizes the long-run speed of adjustment after coming to an equilibrium state from the short run. This study applied other tests also like the CUSUM and CUSUMSQ test for stability analysis. If these tests are within the boundary of a 5% significance level then the regression model is considered stable.

RESULTS AND DISCUSSIONS

SUMMARY STATISTICS

This section analyses the descriptive statistics of the key variables. Table 3 reveals the descriptive statistics of the important variables used in the study. The mean value of growth domestic product per capita (GDPPC) is 1.91% and the median is 1.81% which shows the central tendency of growth. The maximum value is 5.81% and the minimum value of GDPPC is -2.97%. The standard deviation is 2.06. The value -0.14 shows that the data is negatively skewed and the kurtosis depicts flatness in the curve peak. The p-value of 0.73 by Jarque-Bera shows the normal distribution of the data.

The value of mean education (EDU) at the territory level is 4.73% and the median is 3.40%. The maximum value of the variable is 12.5% and the minimum value is 1.84%. The value of the standard deviation is 3.14. The data of EDU is positively skewed and normally distributed as its value is 1.08 and the peak of the kurtosis is flat as its value is 2.82. The Jarque-Bera shows a p-value which is 0.006 that shows data is not normally distributed.

The mean value of the employment-to-population ratio (EPR) is 50.2% and the median is 50.0% which shows the central tendency of the employment ratio. The maximum value is 52.7% and the minimum value of EPR is 40.8%. The standard deviation is 1.03. The value 0.61 shows that the data is positively skewed and the kurtosis depicts the highest peak in the curve. The p-value of 0.91 by the Jarque-Bera test shows a normal distribution of the data.

The mean of gross domestic savings (GDS) is 10.5% and the median is 9.65%. The maximum value of GDS is 17.3%, and the minimum value is 3.43%. The standard deviation is 3.53. The data of the variable is positively skewed and normally distributed, as its value is 0.24, and the peak of the kurtosis is flat, as its value is 2.00. The p-value shown by Jarque-Bera is 0.26, revealing that the data is normally distributed.

The mean value of population density (PD) is 189.0 and the median value is 186.0 which determines the central trend of population growth. The maximum value is 306.5 and the minimum value of population density is 81.08. The standard deviation is 71.4. The value of 0.06 shows that the data is positively skewed and the kurtosis value of 1.67 depicts flatness in the peak of the curve. The p-value of 0.14 by the Jarque-Bera test determines the non-normal distribution of the data.

Table 3: Summary Statistics of Key Variables (1972-2023)

	GDPPC	EDU	EPR	GDS	PD	LE	PGR	RLFWA	TDR
Mean	1.915	4.736	50.223	10.517	189.086	61.416	2.642	0.952	82.874
Median	1.816	3.400	50.084	9.650	186.025	60.847	2.830	0.972	85.807
Maximum	5.818	12.598	52.731	17.399	306.558	66.756	4.423	1.018	92.094
Minimum	-2.970	1.847	48.076	3.433	81.089	55.239	1.204	0.596	68.041
Std. Dev.	2.065	3.148	1.037	3.535	71.495	3.486	0.780	0.074	7.445
Skewness	-0.147	1.084	0.617	0.249	0.063	-0.080	0.023	-3.744	-0.552
Kurtosis	2.551	2.868	3.100	2.002	1.670	1.866	2.335	17.067	1.811
Jarque-Bera	0.625	10.214	3.316	2.697	3.870	2.844	0.962	550.233	5.707

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Probability	0.732	0.006	0.191	0.260	0.144	0.241	0.618	0.000	0.058

The value of the mean of life expectancy (LE) is 61.41 and the value of the median is 60.84. The maximum value of LE is 66.7 and the minimum value is 55.2. The standard deviation value is 3.48. The variable's data is negatively skewed and normally distributed as its value is -0.08 and the peak of the kurtosis is flat as its value is 1.86. The p-value shown by Jarque-Bera is 0.24 exposing that data is normally distributed.
The mean value of the population growth rate (PGR) is 2.64% and the median value is 2.83% determining the internal tendency of population growth. The maximum value is 4.42% and the minimum value of population growth is 1.20%. The standard deviation is 0.78. The value 0.02 shows that the data is positively skewed and the kurtosis value 2.33 portrays flatness in the peak of the curve. The p-value of 0.61 by the Jarque-Bera test determines the normality distribution of the data.
The RLFWA (ratio of the labor force to working age population (15-64 years)) mean is 0.95 and the median value is 0.97. The maximum value of the variable is 1.01 and the minimum value is 0.59. The standard deviation value is 0.07. The -3.74 shows that data is negatively skewed and the peak of kurtosis is very high as its value is 17.06. The p-value determines the non-normality in the distribution of data.
The value of the mean of the total dependency ratio (TDR) is 82.87 and the value of the median is 85.80. The maximum value of TDR is 92.0 and the minimum value is 68.0. The standard deviation value is 7.44. The variable's data is negatively skewed and normally distributed as its value is -0.55 and the peak of the kurtosis is flat as its value is 1.81. The p-value shown by Jarque-Bera is 0.05 exposing that data is not normally distributed.

Table 4: Correlation Analysis of Key Variables (1972-2023)

	GDPPC	EDU	GDS	PD	LE	PGR	RLFWA	TDR
GDPPC	1.000							
EDU	-0.093	1.000						
GDS	-0.103	-0.527	1.000					
PD	-0.046	0.895	-0.297	1.000				
LE	-0.006	0.873	-0.308	0.989	1.000			
PGR	0.008	-0.790	0.298	-0.839	-0.799	1.000		
RLFWA	0.165	0.006	-0.084	0.084	0.113	0.054	1.000	
TDR	-0.046	-0.912	0.664	-0.873	-0.872	0.777	-0.031	1.000

CORRELATION ANALYSIS OF KEY VARIABLES

This section presents the analysis of the correlation of key variables used in the study. Table 4 evaluates the correlation results between different key variables. GDPPC is weak positively correlated with PGR, RLFWA, and weak and negatively correlated with EDU, GDS, PD, LE, and TDR. The EDU is positively and strongly correlated with PD and LE, weak positively correlated with RLFWA, and, moderately negatively correlated with GDS while strongly negatively correlated with PGR and TDR. The GDS is weak positively correlated with PGR and moderate positive correlated with TDR while, weak negative correlated with PD, LE, and RLFWA. The PD is weak positively correlated with RLFWA and strongly correlated with LE whereas, it is strongly negatively correlated with PGR and TDR.
The LE is weakly correlated with RLFWA and strongly negatively correlated with PGR and TDR. The PGR is strongly positively correlated with TDR and weakly positively correlated with RLFWA. The RLFWA is weak and negatively correlated with TDR.

UNIT ROOT ANALYSIS

This section presents the unit root analysis of key variables. To check the unit root evaluations ADF test is used.

Table 5: ADF Unit Root Test Results

Variables	None	Lag	Intercept	Lag	Trend and Intercept	lag	Conclusions
GDPPC	-3.82 (0.0003)	0	-6.34 (0.0000)	0	-6.30 (0.0000)	0	I (0)
EDU	1.66 (0.9755)	0	0.28 (0.9755)	0	-1.81 (0.6813)	0	I (1)

EPR	-1.09 (0.2441)	0	-2.52 (0.1163)	0	-2.19 (0.4807)	0	I (1)
GDS	-0.9846 (0.2868)	0	-1.732 (0.409)	0	-1.860 (0.66)	0	I (1)
LE	5.18 (1.0000)	0	-1.20 (0.6662)	0	-2.14 (0.5107)	0	I (1)
PD	0.69 (0.8627)	1	-0.03 (0.9503)	1	-2.55 (0.3001)	0	I (1)
PGR	-3.69 (0.0323)	1	-0.87 (0.7891)	2	-3.69 (0.0323)	1	I (0)
RLFWA	0.12 (0.7183)	1	-4.78 (0.0003)	1	-4.75 (0.0018)	1	I (0)
TDR	-1.90 (0.6352)	3	0.32 (0.9771)	2	-1.90 (0.6352)	3	I (1)

ADF test is used to check the unit root analysis of the variables. The test is used on the level to check the data of variables. Table 5 shows the ADF unit root analysis of the key variables. The data of GDPPC is stationary at none, intercept, and trend & intercept with lag 0. EDU has a unit root at none, intercept, and trends & intercept with lag 0. EPR, LE, and GDS are stationary at none, intercept, and trends & intercept with lag 0. The variable PD has unit root in none and intercepts with lag 1, while in trends & intercept lag is 0. The PGR is stationary at none and trends & intercept with lag 1 but not stationary at intercept with lag 2. The variable RLFWA is not stationary at none with lag 1 while it is stationary at intercept and trends & intercept with lag1. The TDR has a unit root at none and trend & intercept with lag 3 and intercept with lag 2. The study concludes that there is a mixed order of integration. Variables are stationary and not stationary in mixed form.

BOUNDS TEST RESULTS

This section examines the study of the bounds test. To check the cointegration, the bound test is used in terms of F-statistics. Table 6 shows the bound test results.

Table 6: Results of Bounds Test based on F-statistic

Test Statistic	Value	Significant	I (0)	I (1)
F statistics	5.931	10%	1.92	2.89
K		5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.90

The value of F statistics is 5.931 which is used to determine the presence of cointegration. The critical values represented by I (0) and I (1) provided for different levels of significance (10%, 5%, 2.5%, and 1%). These critical values are compared with the F statistics value. The value of F-statistics shows the overall significance of the model. The critical value is less than F statistics at a 1% significance level (3.90), so the null hypothesis is rejected and the calculated result shows that there is a cointegration among variables and a long-run relationship exists between the variables.

LONG RUN RESULTS

This section explains the long-run estimates of growth. Education is the first independent variable that has a positive relationship with GDP growth. Through improving human capital, encouraging innovation, and expanding job opportunities, education propels economic progress. An educated and trained workforce increases labor productivity, which boosts industry output and efficiency. Education also fosters innovation and technological progress, which helps economies create new sectors and enhance existing manufacturing techniques. Improved work prospects brought about by higher education levels lower unemployment and raise earnings, which in turn stimulate economic activity and consumer spending Dollar & Gatti (1999), Romer (1999), Pritchett et al. (2001), and Hanushek & Woessmann (2008).

Gross domestic saving (GDS) has a positive impact on growth. Reasons for this positive relation are as: Firstly, higher saving rates lead to an increase in economic growth with time as higher saving leads to economic

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CJSSR
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
Vol.03 No.02 (2025)

development and high GDP per capita (Masih & Peters, 2010). Secondly, high saving rates significantly fueled its GDP by providing capital for investments in infrastructure, and technologies and contributing to economic stability (Yao, 2014). Thirdly, when individuals and businesses save, this reduces consumption and allocates resources to investment which leads to increased economic growth and results in higher GDPPC (Modigliani, 1986). This study is in consent with the following studies: Masih & Peters (2010), Yao (2014), and Modigliani (1986).

Table 7: Long-Run ARDL Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EDU	0.614	0.359	1.708	0.097
GDS	0.875	0.380	2.303	0.028
PD	-0.201	0.076	-2.636	0.013
LE	2.621	0.989	2.650	0.012
PGR	1.795	0.410	4.379	0.000
RLFWA	-1.956	0.540	-3.620	0.001
TDR	-1.377	0.519	-2.654	0.012
C	-11.882	50.199	-0.237	0.814

Population density (PD) has a negative relation with GDP growth per capita. The reasons for this negative relation are as: Firstly, higher population density can lead to resource depletion like water, land, and minerals which leads to a negative impact on economic growth per capita (Malthus, 1986). Secondly, an increase in population leads to environmental degradation involving air and water pollution, and deforestation that causes a negative impact on GDPPC (Stern, 2008). Thirdly, a reduction in agricultural productivity due to higher population leads to a negative impact on growth per capita as more people compete for land and resources that are limited (Boserup,2014). The results are in line with the following studies: Malthus (1986), Stern (2008), and Boserup (2014).

Life expectancy has a positive coefficient which means it has a positive relationship with GDP growth per capita. As life expectancy is an important indicator of human capital accumulation, the reasons for this positive correlation are as: Firstly, as LE increases, individuals have more time to invest in education and skills, leading to an increase in production and economic growth (Becker, 1993). Secondly, improved life expectancy is often followed by a reduction in mortality rates, which leads to an increase in economic growth by reducing the economic burden of illness and death (Cutler, 2004). Thirdly, better LE is accompanied by enhanced health consequences, which leads to increased economic growth by reducing healthcare expenses and increasing productivity (Murray, 2013). The findings of the study are matched with the following studies: Becker (1993), Cutler (2004), and Murray (2013).

Population growth has a positive relationship with GDPPC, the reasons behind this positive relation are as: Firstly, PG can lead to an increase in the labor force, which contributes to economic growth by increasing the supply of labor (Solow, 1956). Secondly, population growth leads to economies of scale, as a larger population can support more efficient production and distribution of goods and services (Kaldor, 1963). Thirdly, an increase in the tax base provides governments with more revenue to invest in public goods and services due to higher population growth (Musgrave, 1959). The results are in consent with the following studies: Solow (1956), Kaldor (1963), and Musgrave (1959).

The ratio of the labor force working age population (RLFWA) has a negative relationship with GDP growth per capita. The reason behind this negative relationship is as; Firstly, a lower labor force participation rate can lead to reduced economic growth, as a smaller proportion of the working-age population is contributing to the economy, which leads to a decrease in economic growth (Bloom, 2011). Secondly, when individuals are not participating in the labor force, they are not acquiring skills and experience that can increase their productivity and contribute to economic growth. This can lead to reduced human capital, which can have long-term negative effects on economic growth (Becker, 1993). Thirdly, a high rate of unemployment leads to increased poverty, as individuals who are unable to find work may not have enough income to support themselves and their families this leads to a negative impact on GDPPC (Ravallion, 2013). Fourthly, when the labor force participation rate is low, it can lead to reduced economic productivity, as there are fewer workers to drive innovation and growth (Morrow, 2013). The following studies also show a negative relation Bloom (2011), Becker (1993), Ravallion (2013), Morrow (2013).

The total dependency ratio negatively affects the economic growth per capita of the economy which has reasons that are as: Firstly, when the total dependency ratio is high, it means that there are more dependents (children and elderly) relative to the working-age population which leads to an increased economic burden on the working-age population, as they must support a larger proportion of dependents (Lee, 2011). Secondly, a high total dependency ratio can lead to reduced economic growth, as a larger proportion of the population is dependent on others for support (Bloom, 2011). Thirdly, the negative impact on economic growth per capita is due to a high total dependency ratio that leads to reduced human capital, as individuals may not have the resources or support to invest in education and skills (Becker, 1993). The findings support the following studies Lee (2011), Bloom (2011), and Becker (1993).

ERROR CORRECTION RESULTS

This section shows short-run ARDL estimates. Table 8 depicts the ARDL estimates in the short run, the value of the error term of (GDPPC (-1)) gross domestic product per capita is -1.004 and is statistically significant showing alterations and a strong relationship towards equilibrium.

Table 8: Short-Run ARDL Estimates

Dependent Variable: D(GDPPC)
Selected Model: ARDL (3, 0, 1, 1, 0, 2, 0, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.931	51.292	-0.233	0.818
GDPPC (-1)*	-1.004	0.254	-3.951	0.000
GDS (-1)	-0.616	0.357	-1.728	0.094
PD (-1)	0.879	0.279	3.154	0.004
LE**	-0.202	0.061	-3.310	0.002
PGR (-1)	2.632	0.925	2.846	0.008
RLFWA**	1.803	1.226	1.470	0.151
TDR (-1)	-1.964	4.554	-0.431	0.669
D (GDPPC (-1))	-1.383	0.321	-4.313	0.000
D (GDPPC (-2))	-0.371	0.223	-1.663	0.106
D(GDS)	-0.301	0.150	-2.011	0.053
D(PD)	-0.106	0.190	-0.556	0.582
D(PGR)	-1.249	0.608	-2.053	0.048
D (PGR (-1))	-15.174	6.903	-2.198	0.035
D(TDR)	3.202	1.758	1.821	0.078
D (TDR (-1))	-18.359	6.219	-2.952	0.006

STABILITY ANALYSIS

This section provides a stability analysis of the variables by the graphical representation. The stability of the model is an important issue. To check the stability two tests, that are CUSUM and CUSUMSQ are applied to assess the stability of the model (Pesaran et al, 1997) and these tests were developed by Brown et al, (1975). Figure 1 shows the CUSUM (to check the stability of the model's structure) on the graph with a blue line. The red lines show the upper and lower bonds.

The plot of CUSUM and CUSUM Q are within the boundaries, if the plot lines do not cross the boundary at any level then it accepts the null hypothesis. And if the plot line crosses the boundary at any level then it rejects the null hypothesis. Both Figures 1 and 2 show that the line is within the boundary at a 5% significance level. So, these tests show that the model is stable and accepts the null hypothesis. The figures show that plots of CUSUM and CUSUMSQ tests exist within the critical bounds and show that all coefficients of the short-run model are stable.

Figure 1: CUSUM Test

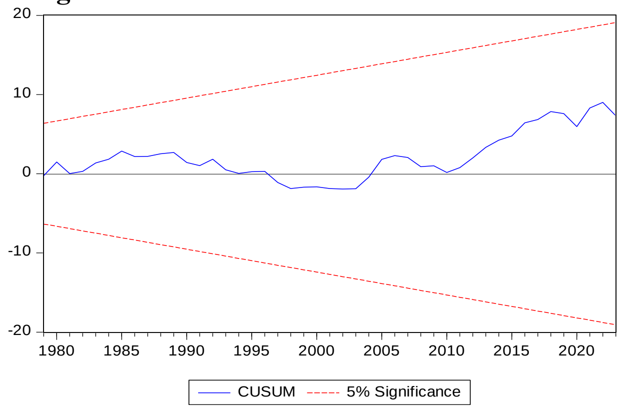
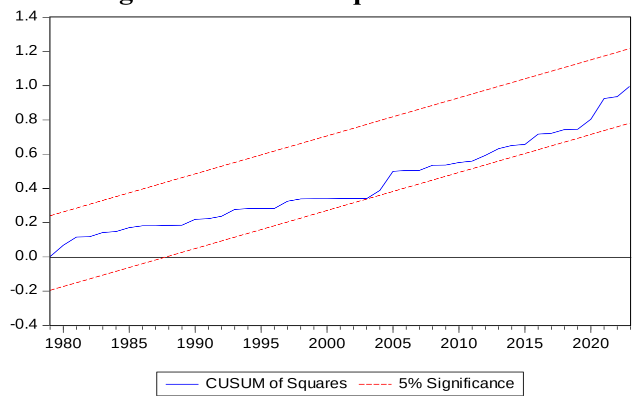


Figure 2: CUSUM Square Test



GRANGER CAUSALITY ANALYSIS

In this section, Granger Causality analysis is presented. The long-run link between variables concludes that there must be a causal relationship between the bidirectional and unidirectional variables (Engle and Granger,1987).

LAG SELECTION

Optimum lag is used for selection. Three criteria for lag selection used are the Akaike information criterion (AIC), Schwarz criterion (SC), and Hannan Quinn criterion (HQ). Table 9 shows that the optimum lag is 4 as in this, AIC, SC, and HC values are less than other lags.

Table 9: Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-625.7777	NA	40.62715	26.40740	26.71927	26.52526
1	-142.7592	784.9050	1.10e-06	8.948302	11.75510	10.00900
2	12.21182	200.1709	3.10e-08	5.157841	10.45958	7.161375
3	147.5842	129.7319	3.04e-09	2.183990	9.980661	5.130364
4	289.3630	88.61173*	5.80e-10*	-1.056792*	9.234814*	2.832421*

GRANGER CAUSALITY ANALYSIS

Granger causality analysis shows the pairwise correlation of variables. Table 10 shows that at lag value 2, the pairwise Granger causality according to their p-value results that, the causality from EDU, PGR, LE, RLFWA, and TDR to GDP are not stationary, all do Granger cause each other. From GDP to GDS and PD, there is unidirectional causality, as for GDS and PD to GDP they are not significant. From GDS, LE, and RLFWA to EDU there is no causality between them, all do Granger cause each other. There is bidirectional causality from PD, TDR, and PGR to EDU, all 3-effect education. There is unidirectional causality from LE to EDU, GDS to PGR, and TDR, from PD and LE to PGR. There is no stationary causality between pairs GDS to PD, LE, and RLFWA and pairs PD & LE**,** PGR & RLFWA, and RLFWA &TDR. There is bidirectional causality between PD & TDR and PGR and TDR. Table 10 presents that at lag value 3, the pairwise Granger causality test results that, there is no causality between EDU, GDS, LE, PGR, RLFWA, and TDR, with GDP. All the pairs with each other do granger cause each other. There is unidirectional causality from GDP to PD. There is no stationary GDS, LE, PGR, and RLFWA with EDU. They all do Granger cause each other. There is a bidirectional causality between EDU and PD**.** There is unidirectional causality from TDR to EDU but no causality from EDU to TDR**.** The variables PD, LE, and RLFWA with GDS are not significant they do Granger cause each other. There is unidirectional causality from GDS to PGR & TDR but no causality from PGR & TDR to GDS**.** There is unidirectional causality from PD to LE but no effect on LE from PD. There is bidirectional causality between PGR and TDR with PD**.** There is no significant relationship between RLFWA and PD, they do Granger cause each other. There is unidirectional causality from LE to PGR but no causality from PGR to LE**.** There is no stationary relation between RLFWA & LE. There is unidirectional causality from TDR to LE but no causality between LE & TDR. There is no Granger causality between pair RLFWA & PGR, RLFWA & TDR. Both do affect each other. TDR & PGR have a bidirectional relationship between them. At lag 4, the pairwise Granger causality depicts that, there is no causality between pairs

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Vol.03 No.02 (2025)

of EDU, GDS, PGR, LE, RLFWA, and TDR with GDP. There is unidirectional causality from GDP to PD and no causality from PD to GDP. GDS, LE, PGR, RLFWA, and TDR with EDU are not stationary with each other. They do because grangers cause each other. There is unidirectional causality from EDU to PD**.** There is no Granger causality between PD, LE, and PGR, with GDS causing Granger to cause each other. There is unidirectional causality from GDS to RLFWA and TDR**.** The pairs like LE, and RLFWA with PD are not stationary. There is bidirectional causality between PGR &TDR with PD. There is unidirectional causality from LE to PGR, but no causality from PGR to LE. There is no significance between pair RLFWA and LE There is unidirectional causality from TDR to LE, but no causality from LE to TDR. There is unidirectional causality from RLFWA to PGR & TDR**,** but no causality from PGR & TDR to RLFWA. There is bidirectional causality between TDR & PGR.

Table 10: Granger Causality Analysis

H_0	Lag	F- statistics	Lag	F- statistics	Lag	F- statistics
EDU↛GDP	2	0.15249 (0.8590)	3	0.32213 (0.8093)	4	0.23534 (0.9167)
GDP↛EDU	2	0.91434 (0.4081)	3	0.98940 (0.4070)	4	0.28365 (0.8868)
GDS↛GDP	2	1.35782 (0.2676)	3	1.15209 (0.3393)	4	1.27489 (0.2964)
GDP↛GDS	2	2.83904 (0.0690)	3	0.83531 (0.4821)	4	0.97519 (0.4322)
PD↛GDP	2	0.16977 (0.8444)	3	0.66820 (0.5763)	4	2.02423 (0.1099)
GDP↛PD	2	5.67001 (0.0064)	3	3.37157 (0.0271)	4	2.83154 (0.0373)
LE↛GDP	2	0.53604 (0.5888)	3	0.47552 (0.7010)	4	0.86636 (0.4927)
GDP↛LE	2	0.09875 (0.9062)	3	0.18768 (0.9042)	4	0.47661 (0.7526)
PGR↛GDP	2	0.08952 (0.9145)	3	0.79457 (0.5038)	4	0.75766 (0.5591)
GDP↛PGR	2	0.27344 (0.7620)	3	0.29303 (0.8302)	4	0.24338 (0.9119)
RLFWA↛GDP	2	0.14911 (0.8619)	3	0.07803 (0.9715)	4	0.62929 (0.6445)
GDP↛RLFWA	2	0.52195 (0.5969)	3	0.62462 (0.6031)	4	0.42991 (0.7861)
TDR↛GDP	2	0.21021 (0.8112)	3	0.14625 (0.9315)	4	0.59881 (0.6657)
GDP↛TDR	2	0.12001 (0.8872)	3	0.67548 (0.5719)	4	0.53867 (0.7082)
GDS↛EDU	2	0.83820 (0.4391)	3	0.55519 (0.6475)	4	0.72962 (0.5772)
EDU↛GDS	2	0.53902 (0.5870)	3	0.51418 (0.6747)	4	0.51675 (0.7238)
PD↛EDU	2	3.25843 (0.0477)	3	3.70457 (0.0188)	4	2.02353 (0.1100)
EDU↛PD	2	4.14586 (0.0223)	3	2.92666 (0.0447)	4	4.08625 (0.00730
LE↛EDU	2	2.60558 (0.0850)	3	1.80523 (0.1609)	4	0.93686 (0.4528)
EDU↛LE	2	0.11399	3	0.32358	4	0.24440

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CJSSR
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
Vol.03 No.02 (2025)

		(0.8925)		(0.8083)		(0.9113)
PGR↛EDU	2	2.57693 (0.0872)	3	2.02355 (0.1252)	4	1.03055 (0.4037)
EDU↛PGR	2	3.05553 (0.0570)	3	0.82899 (0.4854)	4	0.74913 (0.5646)
RLFWA↛EDU	2	0.05824 (0.9435)	3	0.63683 (0.5955)	4	1.00772 (0.4153)
EDU↛RLFWA	2	0.73030 (0.4874)	3	0.64191 (0.5924)	4	0.36791 (0.8300)
TDR↛EDU	2	3.05061 (0.0572)	3	3.37830 (0.0269)	4	2.01744 (0.1109)
EDU↛TDR	2	3.60609 (0.0353)	3	0.71880 (0.5464)	4	1.19373 (0.3289)
PD↛GDS	2	1.40793 (0.2552)	3	2.19015 (0.1034)	4	1.60425 (0.1926)
GDS↛PD	2	0.47418 (0.6255)	3	1.24647 (0.3050)	4	1.07679 (0.3812)
LE↛GDS	2	0.27214 (0.7630)	3	0.38212 (0.7664)	4	0.62812 (0.6453)
GDS↛LE	2	2.19471 (0.1232)	3	1.44989 (0.2419)	4	1.07224 (0.3833)
PGR↛GDS	2	1.54644 (0.2241)	3	1.75718 (0.1700)	4	1.64501 (0.1825)
GDS↛PGR	2	3.64136 (0.0342)	3	3.01235 (0.0406)	4	2.09010 (0.1006)
RLFWA↛GDS	2	0.00990 (0.9901)	3	1.33319 (0.2764)	4	0.84141 (0.5074)
GDS↛RLFWA	2	0.03315 (0.9674)	3	0.41740 (0.7414)	4	3.47738 (0.0160)
TDR↛GDS	2	1.75349 (0.1848)	3	1.88721 (0.1464)	4	2.01242 (0.1117)
GDS↛TDR	2	3.65700 (0.0338)	3	5.37779 (0.0032)	4	4.64459 (0.0037)
LE↛PD	2	0.77684 (0.4659)	3	0.82755 (0.4862)	4	0.80996 (0.5265)
PD↛LE	2	2.24916 (0.1172)	3	2.59164 (0.0653)	4	1.94240 (0.1227)
PGR↛PD	2	1.50819 (0.2323)	3	3.36493 (0.0273)	4	2.36431 (0.0690)
PD↛PGR	2	6.35452 (0.0037)	3	3.81746 (0.0166)	4	3.76965 (0.0110)
RLFWA↛PD	2	0.16800 (0.8459)	3	0.64873 (0.5882)	4	0.46260 (0.7627)
PD↛RLFWA	2	0.46619 (0.6304)	3	0.12836 (0.9427)	4	0.0983 (0.9824)
TDR↛PD	2	2.94473 (0.0628)	3	2.47831 (0.0743)	4	2.79285 (0.0393)
PD↛TDR	2	14.2158 (2.E-05)	3	6.88821 (0.0007)	4	6.59411 (0.0004)
PGR↛LE	2	0.19187	3	0.92187	4	1.34491

		(0.8261)		(0.4386)		(0.2707)
LE↛PGR	2	5.12950 (0.0098)	3	3.37459 (0.0271)	4	2.66383 (0.0467)
RLFWA↛LE	2	1.20485 (0.3092)	3	0.58277 (0.6296)	4	1.04077 (0.3986)
LE↛RLFWA	2	0.63775 (0.5332)	3	1.68872 (0.1840)	4	1.39129 (0.2549)
TDR↛LE	2	3.87760 (0.0279)	3	2.84915 (0.0488)	4	2.23178 (0.0832)
LE↛TDR	2	1.72492 (0.1898)	3	0.7686 (0.5181)	4	1.11625 (0.3628)
RLFWA↛PGR	2	0.03898 (0.9618)	3	0.94706 (0.4266)	4	3.41142 (0.0174)
PGR↛RLFWA	2	0.06512 (0.9370)	3	0.01895 (0.9964)	4	0.11626 (0.9760)
TDR↛PGR	2	4.36449 (0.0185)	3	4.27417 (0.0101)	4	3.35687 (0.0187)
PGR↛TDR	2	26.6668 (2.E-08)	3	9.63072 (6.E-05)	4	6.03575 (0.0007)
TDR↛RLFWA	2	1.19216 (0.3130)	3	0.65646 (0.5834)	4	0.73401 (0.5744)
RLFWA↛TDR	2	0.04513 (0.9559)	3	1.44508 (0.2433)	4	3.09577 (0.0263)

CONCLUSIONS AND POLICY RECOMMENDATIONS

The study examines the impacts of demographic transition on economic growth in Pakistan. The study has used many factors to describe the relationship between population and GDP growth. The variables are population density, employment to labor ratio, ratio of labor force working age population, life expectancy, gross domestic saving, total dependency ratio, and education are used as independent variables, whereas GDP per capita growth is used as a dependent variable. The population density, ratio of labor force working-age population, and total dependency ratio have a negative relationship with GDP per capita growth. Education gross domestic savings and life expectancy have a positive impact on growth. The study used the time series data that starts from 1972-2023. The study has applied the ARDL model. The study concludes that the population has a great burden on the economic growth of Pakistan. If a population is not controlled, then it can be very harmful to the economy. The causal relationship between demographic change and economic growth is investigated by the econometric model and the Granger causality model. There is unidirectional causality between gross domestic saving, population density, and GDP per capita growth. There is no causality between education, life expectancy, and ratio of labor force participation. There is bidirectional causality between the population growth rate and total dependency ratio.

Some policies in accordance with demographic change and economic growth are as follows.

- Education has a positive impact on economic growth. So, it is recommended that the government should make policies to invest more in the education sector as it increases the economic growth in Pakistan.
- Gross domestic savings has a positive impact on economic growth. Therefore, it is suggested that policymakers should make such policies that improve the gross domestic savings in Pakistan to boost economic growth.
- Population density has a negative impact on GDP per capita growth or economic growth. It is suggested that planners must make policies that reduce the population density as it improves the economic growth in Pakistan.
- The outcome of the study shows that an increase in life expectancy has a positive impact on economic growth. So, the government should invest in the health sector to improve life expectancy which in turn boosts the economic growth in Pakistan.

- The variable population growth rate has a negative impact on economic growth. So, it is suggested that planners should make and implement such policies that increase the population growth in order to enhance the economic growth in Pakistan.
- The ratio of the labor force working age population has a favorable impact on economic growth. So, it is recommended that policymakers should such policies that enhance the labor force in order to boost the economic growth in Pakistan.
- Total dependency ratio has an adverse impact on economic growth. So, it is suggested that policymakers should implement such policies that reduce the dependency ratio in order to improve the economic growth in Pakistan.

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