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An Empirical Investigation Of Population Change's Effect On Economic Growth: A Review Of Pakistan

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ABSTRACT
The study experimentally provides insight to determine the long-term implications of population change's and capital stocks along with the control variables of savings rate and trade openness on economic growth in Pakistan. Auto Regressive Distributive Lags (ARDL) assessment procedure has been utilized to decide the longest relationship of 47 years (1972-2018). The results show that, 1% increase in the population changes measured by dependency ratio reduces economic growth (GDP growth) by 14.9% over the long run. Outcomes additionally influence saving rates, as a 1% increase in savings in a country results in an increase of about 28% in economic growth over the long run. Gross capital formation has an insignificant positive impact on EG. Therefore, policies should be formulated by the Government of Pakistan to decrease the dependent population, accelerate savings, upgrading the trading environment and improve the infrastructure of the economic system to support capital formation.

Keywords: Economic Growth, Population Changes, Gross Capital Formation, Saving Rate, Trade Openness.

JEL Codes: O4, J10, H54, E20, F10.

1 INTRODUCTION

Over the past few decades, significant demographic changes in the aging structure of the population have been occurring quickly, not only in the developed countries but as well as in the developing world. These changes can result in long-term economic consequences.

Different demographic variables for example fertility rate, life expectancy, population size, population growth, and population density can conceivably influence an economy (Uddin et al., 2016). Although, every one of these variables independently does not show the full impact of a nation's demographic transition. Uddin et al., (2016) and Wei & Hao, (2010) contented that the dependency ratio shows the age structure of the population and could more accurately capture the overall effect of demographic changes. A systematic investigation of these changes is significant because both young and old person are probably more reliant on the economically working age population. Increasing the number of dependent people can decline the economic growth (Santacreu, 2016). As briefed, economies vary in their ability to obtain demographic dividend, inspite an appropriate demographic structure depending on public investment and policy strategy. Therefore, the problem is an experimental problem that requires proper quantitative analysis.

Pakistan is undergoing a demographic transition with a declining trend in fertility rates. With an increase in the working age population and a decrease in dependency ratio, it is presently encountering a once-in-a-lifetime demographic dividend (Durr-e-Nayab, 2008). Although some previous studies figured out the issue for Pakistan e.g. (see Choudhry & Elhorst, 2010; Iqbal et al., 2015; Jehan & KHAN, 2020). Despite the significance of the relationship between the changed demographic structure and economic growth, to the degree of knowledge, the study of the long-term relationship between demographic structure and economic growth has not been done appropriately in literature particularly in Pakistan, with the necessary experimental rigor and reasonable data base. Against this background, due to the assistance of 47-year significant period of 1972-2018, this study seeks to understand the long-term impact of altering demographic pattern on Pakistan's economic growth because of the dependency ratio and savings, and other related variables for example Trade openness and capital formation using "Auto Regressive Distributive Lags (ARDL)", a highly advanced econometric technique in order to decide the long-term relationship between related variables.

2 LITERATURE REVIEW

In recent times, the impact of demographic changes on economic growth has been thoroughly researched using data from many economies and groups of economies. Bawazir et al., (2019) studied the impact of demographic change on EG in Middle Eastern economies. They examine the impact of age and sex based classified working-age population on economic growth. A positive association between all age groups, i.e. the population growth rate and the old dependency ratio, was discovered. Conversely, young dependency ratio is negatively correlated with economic growth. Kajimura, (2020) assessed the effect of population changes on economic growth using data from East and Southeast Asia. He found that an ageing workforce limited long-term economic growth. In contrast, higher life expectancy and a lower young population ratio will increase labor force participation and reduce the negative impacts of population ageing. Using regional panel data for demographic variables based on empirical models of economy growth, Erbiao & tatsuo, (2019) claim that Japan's recent demographic changes influenced regional economic growth from 1980 to 2010. The demographic dividend, or the difference in growth rates between the total working force and the total population, has disappeared. Also, the ageing of the population (65+) slowed the rise of the GRDP per capita.

The 0-14 age group made a significant contribution. Subsequently, Miri & Maddah, (2018) used an ARDL model to analyze the impact of population age structure on Iran's economic growth from 1987 to 2017. The population was divided into three age groups: 0-14 years, 15-64 years (active population), and over 64 years. The outcomes of this study show that the impact of the 0-14 age group on economic growth is minimal. The influence of population growth shares of 15-64 year olds on economic growth is positive and significant both in short and long term. Moreover, the impact of the over-65 population growth share on economic growth is negative and long-term. Sinnathurai, (2013) studied poverty, economic growth, agricultural and industrial employment, and dependence ratio. On found a substantial positive association between dependency ratio and poverty incidence in 41 countries comprising Sub Saharan Africa, Latin America, and Asia. However, the regression results do not offer the cross-country analytical diagnosis test of heteroscedasticity. In this case, the findings cannot be used to make policy since the parameters are misleading.

Basu et al., (2013) have attempted to discover the decreasing dependency ratios' impact in the BRICS nations which are (Brazil, Russia, India, China and South Africa) in comparison to developed countries. It was discovered that the initial level population growth rate and working age population significantly affects the economic growth. Additionally, Olabiyi, (2014) examine the impact of population dynamics on economic growth in Nigeria from 1980 to 2010 by applying vector auto regression (VAR) model. Infant mortality rate, trade openness, fertility, real GDP, government expenditures, and primary school enrollment are revenue factors. Using time series data, the study indicated that economic growth was increasing whereas rate of fertility has been decline. The infant mortality rate and economic growth correlated positively. From 1997 to 2008, Van der Ven & Smits, (2011) studied the effect of population dynamics (age structure) on economic development in emerging nations. The working-age population boosts GDP growth. To help the growing young population, the researcher suggests that the government should foster an investment-friendly climate. Shifting the focus from world to Asia, Bloom et al., (2010) looked the effect of ageing population on economic growth in Asia from 1960-2005. They used fixed panel regression.

RGDP per capita and average secondary school enrolment were represented by dummy variables. Population ageing and economic growth were linked in the findings. Trade openness and other institutional factors are positively linked to economic growth. On the other hand, Aiyar & Mody, (2011) used 22 Indian States panel during the period 1961 to 2001 to investigate the effect of working age ratio on economic growth. The findings state positive linkage between the variables used. In the context of Pakistani research, Hussain et al., (2010) investigate the demographic factors effect on economic growth from 1972 to 2006. The country's GDP growth rate is hampered by low fertility and high infant mortality. The influence of labour force expansion on economic growth is negligible. Choudhry & Elhorst, (2010) found that 25% of the changes in per capita GPD growth is explained by population dynamics in Pakistan. Pakistan's economic growth from 1974 to 2011 was studied by Iqbal et al., (2015) for the effect of demographic change. They found that population change had a positive long-term impact on economic growth, but a negative short-term effect. Finally, Jehan & KHAN, (2020) Pakistan's economic development and physical capital have been negatively impacted by demographic factors from 1960 to 2014.

Demographic change is assessed by looking at factors such as population growth, dependency ratios among the elderly, working age population, and the young age dependency ratio. The study indicated that the total negative effect is largest for old age dependency, threatening population increase, while young age dependency causes the least threat. The significance of capital sock in mediating the relationship between demographic change and economic growth was also underlined. Therefore, the literature review highlights the need for current research, as the vital relationship among country's population age structure and economic growth that has not been inspected in detail. This study is one of the few studies detecting the Impacts of population change on economic growth in Pakistan. This study gives a huge contribution to the current literature and may differ from the past investigations as current research is largely descriptive in nature, without considering the analytical need for such an analysis. In addition, to the best of author's knowledge, no investigation has fused the most recent econometric technique of ARDL to detect the long run relationship between the variables in context of Pakistan for the time period of 47 years (1972-2018).

3 RESEARCH METHODOLOGY

3.1 Theoretical Model

In this section of methodology, the study uses the famous neo-classical growth theory. The hypothesis of neo classical growth theory considered the detailed and comprehensive treatment of income and population as crucial factors while dealing with the investigation of economic development of a country. As cited in (Akintunde & Oladeji, 2013), the financial analyst of neo classical theory opine that technological progress is linked with the population growth for positive economic growth results. The neoclassical growth hypothesis holds that growth in total efficiency or output can be accomplished either by means of increment in savings or reducing population growth rate. Grabowski & Shields, (1996) explain in their study that when the population is increasing gradually, less savings and investment will be required for capital expansion. Therefore, more investment and saving will be available for capital formation. The model of neoclassical growth theory is given below;

$$\mathbf{Y = AF\ (K, L)} \qquad \mathbf{(1)}$$

Where:

- **Y –** Gross Domestic Product (GDP) / income of the economy.
- **K –** Capital
- **L –**Economy's unskilled labor amount.
- **A –** Is the factor of productivity (i.e. exogenously determined level of technology).

This study used an augmented form of neoclassical growth model where population dynamics such as factors that applies changes in population are represented by proxy "vector of variables" while vector of all other variables that are influencing economic growth are employed as control variable (Z) and demographic factor (A) respectively. Subsequently labor is excluded from the model due to lack of consistent data or suitable proxy in Pakistan data selected for the specified period, resultantly equation 1 is modified as follows;

$$\mathbf{Y/A_{g(t+n,t)}} = \mathbf{y}(\mathbf{A_t}, \mathbf{K}; \mathbf{Z_{t+n,t)}}) \qquad \mathbf{(2)}$$

In Eq: 2, ⍰**/A**⍰ represents growth rate of per capita GDP for the interim period of **(t+n, t)** and it varies at per capita income initial level with **(A⍰)**. Education and population density variables are represented with **(A_t)**, **K** denotes the capital stock calculated by Gross Capital Formation while factors impelling the economic environment variables and also changes in political strength, return on investment, savings, openness of trade and the similarities are denoted by Z also called control variables. Levine & Renelt, (1992) proved that the strongest variable was organized by investment rates in such studies. Barro & Lee, (1993) reviewed new-classical growth theory with substitute demographic conditions, including youth dependency ratio and total population growth. There are several reasons for employing saving rate, trade openness in our model. The main component of this model is that it can be functional and restructured in a modified way by incorporating diverse productivity assumptions, or diverse dimension measurements. As such the study uses the context and reformulate it into a model by utilizing some additional variables as stated by (Mahmud, 2015).

Bloom et al., (2003) and Prskawetz et al., (2007) found that the level of savings affects the growth of working age population hence dependency ratio is used as an alternative as an alternative of population growth rate. As a result, in this research, the impact of dependence ratio as a major variable on economic growth is that a larger working-age population indicates a lower dependency ratio, which leads to a greater workforce per capita ratio and, as a result, an increase in labor supply in the economy. This also shows that more savings are generated due to higher number of age group than dependents, leading to more savings which ultimately pave the way for fruitful investment in the economy. Hence more savings leads to more investments and creation of capital which leads to economic growth (Uddin et al., 2016).

3.2 Estimation Model

Demographic changes is measured by using dependency ratio as proxy, while physical capital is measured through Gross capital formation. Saving Rate and Trade Openness are used as accelerator to develop a simple growth model and estimated by involving the theoretical structure of the model of neoclassical growth theory established by (Barro & Sala-i-Martin, 1992). The present section of the study fits the association of age dependency ratio along with other variables into the model as under;

$$\mathbf{RGDP_t = f(DR, GCF, SR + OPN)_t} \qquad \textbf{(3)}$$

Where Demographic factor (A) is calculated by using DR, GCF represents the capital stock (K) and saving rate (SR) and trade openness (OPN) defined the control variables (Z). The definition and source of data collection are mention in the table-3.1 of dependent and in dependent variables.

Table 3.1: Definitions of Variables.

Variable Name	Definition	Source
GDP	GDP is the annual percentage growth rate in constant local currency of the Gross Domestic Product (GDP).	(World Bank 2018)

DR	Dependency ratio (DR) is the combination of the population older than 64 plus population younger than 15 per working age population having ages of 15 to 64. Data is accessible as the percentage of dependent population each 100 working age population.	(World Bank 2018)
GCF	Gross capital formation; estimated as percentage of GDP denoted by GCF (earlier called gross domestic investment), is applied as proxy for capital stock. The GCF included expenditures for adding to the economy's fixed assets as well as net variations in the degree of inventories.	(World Bank 2018)
SR	Saving rate denoted by SR is measured as percentage of GDP with the formula (gross national income - total consumption and adding net transfers)	(World Bank 2018)
OPN	Trade openness denoted by OPN is measured as a portion of GDP which is the exports of goods and services plus imports.	(World Bank 2018)

Data of variables are annual and covers the period 1972–2018 for Pakistan.

Equation 3 when presented in econometric forms can be represented in equation 4;

$$\mathbf{GDP_t = \beta_0 + \beta_1 DR_t + \beta_2 GCF_t + \beta_3 SR_t + \beta_4 OPN_t + \varepsilon_t} \qquad \mathbf{(4)}$$

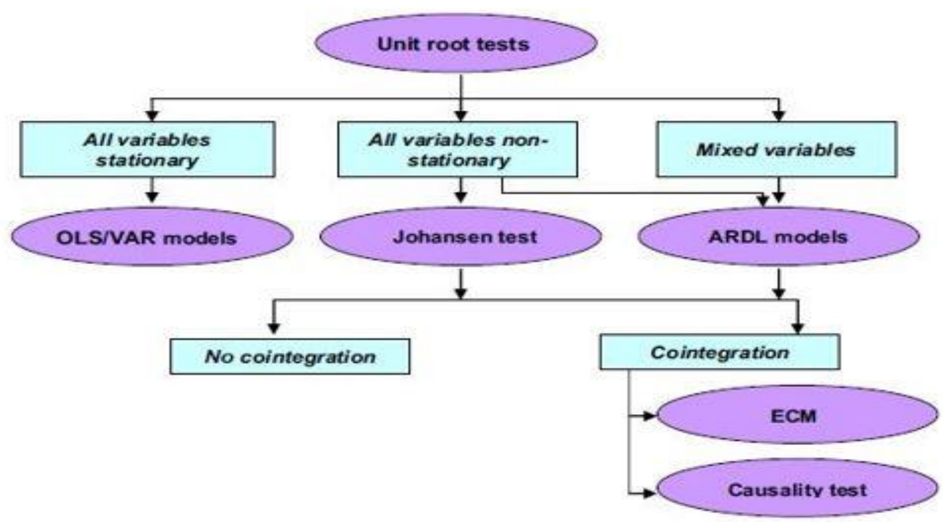
Where β_0, $\beta 1$, $\beta 2$, $\beta 3$ and $\beta 4$, are the coefficients of DR, GCF, SR and OPN respectively with the error term, εt against real GDP growth. While "t" represents the time period from t= 1---N. The long term elasticity estimates of real GDP against the other variables are shown through these coefficients. The model presents that co-efficient shows long run conflict evaluation of GDP growth rate against the independent variables (Bloom et al., 2013). GDP growth is the dependent variable used as a substitution of economic growth. GDP is also used by (Aidi et al., 2016) in order to measure the economic growth.

3.3 Method Selection Framework

In time series data, Applying the most suitable methodology is the most important part of analysis as incorrect model selection or applying inappropriate technique comes up with biased and unpredictable estimates. Basically, selection of technique for time series data analysis are primarily depends on the unit root test's findings as these results tells us the stationarity of the variables. Non-stationary series cannot be analyzed using the same tools and methodologies that are used to explore stationary time series data. The procedure becomes easy when all of the variables are stationary. In such case, OLS or VAR models can produce acceptable estimates. On the other hand, if all of the variables are not stationary, or if some of the variables are stationary but others are not, OLS or VAR models maybe inappropriate for examining the correlation. When the variables used in the study are of mixed character, new problems occur.

The first difference of variable is used to convert non-stationary data into stationary data. However, long-term trend non-stationarity data can be converted to stationary form by applying a regression model with a time variable or by employing a filtering approach like the Hodrick Prescott (HP) filter, which can identify trends and cycles from a single series. It should be emphasized, that if the data is changed to make it stationary by converting to first difference, de-trend, or filtering, the long-term relationship data of the variables will be lost. The entire methodological framework for time series analysis is shown in Figure 3.1. The technique selection criteria shown in Fig. 3.1 should be regarded as the most important approach. This is due to the fact that time series models have a number of other factors to consider.[1]

Fig. 3.5.1 Method Selection for Time Series Data



3.4 Unit Root Test

The unit root test of variables can be used to begin the time series data analysis. If all the variables are stationary indicated by the unit root test results, then the OLS approach can be used to determine the correlation between variables. If the variable is not stationary as shown by the unit root test findings, it can be transformed to stationary form by taking the

[1] See (Shrestha & Bhatta, 2018) for detailed discussion on unit root test with the structural break

first and second difference forms of the variable. The stationary time series is represented by I(0) if it does not need to be differentiated. While If a time series becomes stationary after only one difference, it is called integrated of order one I(1), and if it needs be differed numerous times to become stationary, it is called integrated of order two I(2). Now if OLS regression is applied on the variables having zero difference I(0), first difference form I(1) and difference at integrated order 2 i.e. I(2), it looks simple and easier to analyze the relationship.

But as mentioned before that by taking difference of the variables, it lose the long run information and the difference form variables will only show the short run change in the time series data. Therefore OLS method is not recommended when the variables are converted to stationary form by taking difference of the non-stationary variables. That's why the stationarity of a time series is assessed using unit root test. There are numerous tests created in order to check the stationarity of time series data. Which are Dickey & Fuller, (1979), Augmented Dickey & Fuller Test, (1981), Phillips & Perron Test, (1988), and (Kwiatkowski et al., 1992) test to check the stationarity. In This investigation, the stationarity of variables was tested using the unit root trial of Augmented Dickey–Fuller Generalized Least Squares (ADF-GLS) method by (Elliott et al., 1992) which is the advanced version of (Dickey & Fuller, 1981).

3.5 Vector Autoregressive (VAR) Model

The Vector Autoregressive (VAR) model is used to allow feedback or reverse causation between dependent and independent variables by using their own past values. All of the regressors in the overall VAR model are assumed to be endogenous, and there are no exogenous variables in the model. In VAR modelling, choosing the right lag length is fundamental. Three of the most frequent lag length selection criteria are: i) Akaike Information Criterion (AIC), ii) Schwartz Bayesian Criterion (SBC), and iii) Hannan Quinn rule (HQC).

3.6 Cointegration Test

Applying Ordinary least square or related techniques to non-stationary time series data can produce incorrect findings. The results of the regression test may reveal a strong and substantial link between unrelated variables. Due to the use of a non-stationarity form of the time series in the regression model, these results are referred to as "spurious regression." On the other hand, despite the fact that variables may diverge from equilibrium in a short-term relationship, two or more variables may have showed a long-term equilibrium relationship. Engle & Granger, (1987) established the co-integration test method to study the non-stationary variables relationship in order to address these challenges. Which contends that if two or more variables are linked in such a way that one variable follows the other through time and the two have comparable movement, the variables are said to be co-integrated.

a) Johansen Cointegration Test

There are some weakness in using Engle Granger methodology therefore (Søren Johansen, 1988) and (Soren Johansen & Juselius, 1990) have devised improved co-integration test models by addressing weakness in the Engle Granger methodology. The (Søren Johansen, 1988)' 14th version has been used with various econometric software and is a very popular technique. The method of this test is built on the connection between the rank of matrix and its roots characteristics.

3.7 ARDL and Error Correction Model

Pesaran & Pesaran, (1997); Pesaran & Smith, (1998) and Pesaran & Shin, (1998) presented the ARDL base cointegration. This technique's key advantage is that it can be used regardless of whether the variables are stationary at integrated order zero or one, i.e. I(0) or I(1) (Pesaran & Pesaran, 1997). The ARDL methodology takes a number of lags of the variables utilized in the model in order to capture the data generating process in a general to specific modelling framework (Laurenceson & Chai, 2003). Furthermore, a dynamic error correction model (ECM) can be generated from ARDL using a simple linear transformation (Banerjee et al., 1993). The ECM incorporates both the short-run and log run equilibrium features without losing long run information contrary to other techniques like OLS where due taking difference form (non-stationary variables to make it stationary) of variables the model lose the long run information. Which confirms that utilizing the ARDL approach remove the problems arising from non-stationary time series data (Laurenceson & Chai, 2003). In order to deal with cointegration relationship between the variables, the ARDL approach in equation-4 was estimated using the following error correction regression;

$$\Delta GDP_t = \beta_0 + \sum_{i=1}^{p} \beta 1\, \Delta(GDP_{t-1}) + \sum_{i=1}^{q1} \beta 2\, \Delta(DR_{t-1}) + \sum_{i=1}^{q2} \beta 3\, \Delta(GCF_{t-1}) + \sum_{i=1}^{q3} \beta 4\, \Delta(SR_{t-1}) + \sum_{i=1}^{q4} \beta 5\, \Delta(OPN_{t-1}) + \alpha_1 GDP_{t-1} + \alpha_2 DR_{t-1} + \alpha_3 GCF_{t-1} + \alpha_4 SR_{t-1} + \alpha_5 OPN_{t-1} + \zeta ECT_{t-1} + \varepsilon_t \quad \textbf{(5)}$$

The first part of the equation with $\beta1, \beta2, \beta3, \beta4$ and $\beta5$ addresses short run dynamics of the model. The second part with α1, α2, α3, α4 and α5 addresses long run relationship. "Δ" addresses the difference form of the variable. "p" and "q" represents the lag estimations of dependent and independent variables respectively. While "ECT" is the error correction term and "ζ" is the adjustment coefficient of ECT. The null hypothesis which implies non-existence of long run relationship in the equation is α1= α2= α3= α4= α5.

3.8 Diagnostic Tests Used in Time Series Model

There are two types of diagnostic test performed in time series data model in order to make the estimates results unbiased and robust which are,

a) Goodness of Fit

In order to assess how well the regression line represents the data, it is evaluated that whether there is a serial correlation in residuals and whether the overall model is significant or not. The Goodness of Fit test value, as well as the predicted coefficients, are displayed in almost all types of software. In bivariate and multivariate regression, R2 and adjusted R2 values are used to determine the goodness of fit respectively. It is said to be preferable if the value is closer to 1. R2 rises as the number of variables in the model grows, while adjusted R2 rises as the estimate power of the new variable improves. Similarly, the autocorrelation in residuals is checked using Durbin Watson (DW) statistics. If DW is close to 2, the model is considered 'autocorrelation free.

b) Diagnostics Tests

Diagnostic tests are performed to ensure that estimated coefficients are stable. Diagnostic tests are calculated individually because they are not usually checked by software. The character of the diagnostic test is determined by the modelling approaches used. The most commonly used diagnostic tests are residual diagnostics, coefficient diagnostics, and lag structure. Residual diagnostics is the most important aspect of economic modelling since it aims to reduce error terms, also known as residuals. Residual diagnostics look for white noise in the error terms, therefore the residuals must be (i.i.d.) "independently and identically distributed." For residual diagnostics, the heteroscedasticity test, correlogram test, and Lagrange multiplier (LM) test are utilized. Similarly, the stability of the variables can be checked using the CUSUM and Square of CUSUM tests to see if the estimated model's parameters are stable across different sub-samples of the data.

4 RESULTS AND DISCUSSION

4.1 Summary Statistics

The detailed statistical analysis of variables used in the model are carried out in the table 4.1. The data set consists the annual observations of 47 years 1972 to 2018. The summary statistics exhibits that the mean of GDP growth is 4.854 with standard deviation of 2.080. DR has an average of 82.412 with standard deviation of 7.910. GCF has 17.438 mean value with the standard deviation of 1.870, the average and standard deviation for SR is 21.673 and 4.136 respectively while the mean and standard deviation for OPN is 32.945 and 3.364

correspondingly. The variable GDP is positively skewed however all the other variables are negatively skewed. The variables' Kurtosis statistic shows that all the variables have positive values and are leptokurtic (long-tailed or higher peak). A Jarque–Bera test in the table shows that all variables are normally distributed except the residual of DR.

Table 4.1: Summary Statistics:

	GDP	DR	GCF	SR	OPN
Mean	4.854	82.412	17.438	21.673	32.945
Median	4.846	87.177	17.875	21.498	33.246
Maximum	10.215	89.372	20.818	30.431	38.909
Minimum	0.813	65.515	12.930	10.123	25.306
Std. Dev.	2.080	7.910	1.870	4.136	3.364
Skewness	0.153	-0.998	-0.594	-0.566	-0.377
Kurtosis	2.724	2.417	2.555	3.538	2.513
Jarque-Bera	0.332	8.475	3.151	3.086	1.579
Probability	0.846	0.014	0.206	0.213	0.453
Sample Size	47	47	47	47	47

4.2 Correlation Matrix

The strength of variables relationship is shown in Correlation matrix table 4.2. The variable GDP growth rate is correlated positively with all variables according to our assumption except DR which needs to be negatively correlated with GDP. Still it's earlier to assume the true relationship between various factors as correlation matrix displays the rough relationship between variables.

Table 4.2: Results of Correlation Matrix:

	GDP	DR	GCF	SR	OPN
GDP	1.000				
DR	0.140	1.000			
GCF	0.239	0.455	1.000		
SR	0.468	-0.000	0.450	1.000	
OPN	0.021	0.481	0.548	0.142	1.000

4.3 Unit Root Test

In order to check the stationarity of variables, Dickey–Fuller Generalized Least Squares (DF–GLS) unit root test is operated at both intercept, intercept and trend level. The results of DF-GLS unit root test in table 4.3 shows that some variables are stationary at level while some are stationary at first difference in both intercept, intercept and trend level having mixed order of integration. Therefore, ARDL cointegration is the most appropriate methodology for determining the long run equilibrium.

Table 4.3: Unit Root Test

Variables	Dickey–Fuller Generalized Least Squares (DF–GLS)					
	Levels			First Difference		
	Test Statistics	Critical Value	Remarks	Test Statistics	Critical Value	Remarks
Intercept						
GDP	-3.403*	-1.948	I(0)	-0.547	-1.949	I(0)
DR	-2.115*	-1.948	I(0)	-0.880	-1.948	I(0)
GCF	-1.644	-1.948	I(1)	-5.252*	-1.948	I(1)
SR	-1.601	-1.948	I(1)	-6.750*	-1.948	I(1)
OPN	-2.183*	-1.948	I(0)	-6.852*	-1.948	I(1)
Intercept and Trends						
GDP	-4.293*	-3.190	I(0)	-7.671*	-3.190	I(1)
DR	-2.599	-3.190	I(1)	-3.482*	-3.190	I(1)
GCF	-2.005	-3.190	I(1)	-5.949*	-3.190	I(1)
SR	-2.208	-3.190	I(1)	-7.362*	-3.190	I(1)
OPN	-2.555	-3. 190	I(1)	-7.379*	-3.190	I(1)

5% level of significance for all the variables is used in DF-GLS unit root test. While I(0) means integrated order zero and I(1) means integrated order one.

4.4 Optimal Lag Selection Using VAR

According to Baek, (2014); Bahmani-Oskooee & Nasir, (2004), it is very important to select the number of required lags in ARDL model, as it can affect the value of F-statistics results.

Table 4.2.4: Test-Statistics:

Lag	LR	FPE	AIC	SC	HQ
0	NA	19759.59	24.08074	24.28553	24.15626
1	299.2844	19.58057	17.15476	18.38350	17.60788
2	87.03701*	4.333432*	15.59764*	17.85034*	16.42837*
3	27.43172	5.712361	15.74445	19.02110	16.95277
4	18.56413	10.27289	16.06341	20.36402	17.64934

*denotes lag order selected by each criterion. FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

The study used Akaike Information Criterion (AIC) criteria based on general-to-specific modelling approach for the selection of optimal lag length because of consistent selector. In Table 4.2.4, AIC results shows that a maximum lag of 2 is chosen for each variable.

4.2.5 Johansen Cointegration Test

The results of the Johansen–Juselius co-integration test (trace test statistics and maximum eigenvalue statistics) support the presence of 3 cointegration vectors at trace statistic and 1 cointegration vector at Max-Eigen statistic at 5% level of significance at intercept. While 2 cointegration equations are present at trace statistic and 1 cointegration equation at Max-Eigen statistic at 5% level of significance at trend and intercept. We conclude that there is a strong evidence of cointegration among the examined variables.

Table 4.5: Johansen Cointegration Test Results:

	Intercept		**Intercept and trend**	
Hypothesized No. of CE(s)	**Trace Statistic**	**Max-Eigen Statistic**	**Trace Statistic**	**Max-Eigen Statistic**
None	103.578*	45.993*	116.159*	46.919*
At most 1	57.585*	24.723	69.240*	27.747
At most 2	32.861*	20.524	41.492	20.656
At most 3	12.337	11.755	20.836	14.108
At most 4	0.582	0.582	6.727	6.727

Note: The rest of the unit root test is carried out at the 5% of significance denoted by *. Lag intervals for test: 1 2. Asymptotic p-values are computed using (MacKinnon et al., 1999).

4.6 Autoregressive Distributed lag (ARDL) Model

Using the equation 5, Bound test is carried out to determine the value of F-statistics by executing the optimum lags on each side of the variables. The table 4.6a results shows that the joint F-statistic calculated value is 9.814. While at the 10%, 5%, and 1% significance levels, the F-statistics lower and upper bounds values are (3.03, 4.06), (3.47, 4.57), and (4.4, 5.72), respectively.

Table 4.6a: Bound Cointegration Test Results:

F-Statistics value	**9.814**	
Significance	I(0)	I(1)
10%	3.03	4.06

5%	3.47	4.57
1%	4.4	5.72

Integrated order zero is denoted by I(0) and I(1) shows integrated order one in Bound test,.

As the value of the F-statistic exceeds the upper bound at the 10%, 5% and 1% significance level, the result for the bound test for co-integration satisfied the assumptions of both Banerjee et al., (1998) and Pesaran et al., (2001) which states that if the value of F-statistics fall outside the lower and upper bounds, then it confirms the evidence of a long-run relationship among the variables.

The findings of ARDL long run results in table 4.6b, shows that the independent variables, DR and SR are significant while GCF and OPN are insignificant. The longest impact on economic growth is caused by saving rate and then by Age dependency ratio. At 5% level of significance the effect of dependency ratio on GDP growth is negative as expected. The coefficient (-0.149) of dependency ratio indicates that one percent increase in dependency ratio will decrease the economic growth (GDP growth) by 14.9% in the long run. Similarly, saving rate has an expected positive effect on GDP growth. The coefficient (0.279) of saving rate indicates that 1% increase in saving rate leads to increase over 27.9% increase in economic growth in long run. The Findings are supported by (Uddin et al., 2016). The variables GCF and OPN have positive and negative insignificant values respectively which shows that gross capital formation and trade openness have no significant role in the enhancement of per capita GDP growth. The positive insignificant effect of GCF on Economic growth agrees with the findings of (Odo et al., 2016; Onyinye et al., 2017). While the negative insignificant effect of trade openness on economic growth agrees with the results of (Moyo et al., 2017). The long run ARDL findings also support the hypothesis of neoclassical-growth model presented by (Solow, 1999).

Table 4.6b: Autoregressive Distributed Lag (ARDL) Long Run Relationship Results

Dependent Variable: Gross Domestic Product Growth Rate (GDP)

Variables	Coefficients	Std. Error	t-Statistics	Prob.
DR	-0.149	0.071	-2.075	0.044
GCF	0.066	0.190	0.346	0.730
SR	0.279	0.073	3.819	0.000
OPN	-0.062	0.090	-0.692	0.493
C	16.891	6.158	2.742	0.009
@TREND	-0.155	0.0473	-3.274	0.002
Diagnostic test statistics	**Test-Stat:**	**p-values**		
F-statistic	4.334	0.001		

Serial correlation LM Test	0.060	0.940
Heteroskedasticity Test	1.609	0.162
R-squared	0.443	
Durban–Watson statistic	1.860	

Notes: ARDL (1, 0, 0, 1, 0) selected based on Akaike information criterion (AIC). Probability values are significant at 5% and 10% level.

The diagnostic tests are carried out in ARDL long run results. The coefficient of determination (R^2) has the value of 0.443 indicating that dependent variable (GDP growth) variation is explained by independent variables (DR, GCF, SR and OPN) by 44.3 percent. While the remaining 55.7 percent is explained by error term which includes variables which are not captured in the model. The F – statistics value is 4.334 with p-value of 0.001, which confirms that the influence of explanatory variables on the dependent variable is statistically significant. The Durbin Watson statistics value (1.860) is nearer to 2, which confirm that there is no auto-correlation between independent variables. The heteroscedasticity test value (1.609) having p-value (0.162) greater than 0.05 significant value also confirmed the absence of Heteroskedasticity in the model. Breusch-Godfrey Serial Correlation LM Test value (0.060) having P-value (0.940) is insignificant at 5% and confirms that there is no serial correlation between the residuals.

Table 4.6c: Autoregressive Distributed Lag (ARDL) Short-Run Relationship Results

Dependent Variable: Gross Domestic Product Growth Rate (GDP)				
Variables	**Coefficients**	**Std. Error**	**t-Statistics**	**Prob.**
Δ(GDP(-1))	-1.099	0.174	-6.305	0.000
Δ(DR)	-0.164	0.086	-1.888	0.066
Δ(GCF)	0.072	0.213	0.339	0.736
Δ(SR)	0.073	0.090	0.806	0.424
Δ(SR(-1))	0.307	0.081	3.772	0.000
Δ(OPN)	-0.068	0.098	-0.700	0.488
C	16.891	2.345	7.200	0.000
@TREND	-0.155	0.027	-5.583	0.000
ECT(-1)	-1.099	0.149	-7.364	0.000
Diagnostic Test Statistics	**Test-Stat:**	**p-values**		
F-statistic	22.455	0.000		
Serial correlation LM Test	0.060	0.940		
Heteroskedasticity Test	1.609	0.162		
R-squared	0.615			

Durban–Watson statistic	1.860

Notes: ARDL (1, 0, 0, 1, 0) selected based on Akaike information criterion (AIC). Probability values are significant at 5% and 10% level. "D" is the difference form of variables.

The results of short run behavior of the variables reported in Table 4.6c are not consistent with the long-run relationship found earlier. The variable DR is significant at 10% level of confidence while all the other explanatory variables are insignificant except for GDP and SR of previous years at 5 % confidence level and signs. However, the error correction coefficient value is -1.099 which is highly significant with the correct negative sign and imply a high speed of adjustment to equilibrium. This ECT significance also confirms the short run cointegration between GDP, DR, SR, GCF and OPN. The coefficient of the error term (ECT_{t-1}) implies that the deviation from long run equilibrium level of (dependent variable) of the current period is corrected by 109% in the next period to bring back equilibrium. Moreover, (M. Banerjee & Sarkar, 2003) stated that if the coefficient value of ECT is highly significant then it means there is an existence of a stable long-run relationship. The diagnostic tests for the model are presented at the bottom of table.

The F- statistics value is significant which confirms the statistical significance of model. There is no neglected heteroscedasticity and autocorrelation as it is confirmed by Breusch-Pagan-Godfrey heteroscedasticity Test, Breusch-Godfrey Serial Correlation LM Test and Durbin Watson statistics value, respectively. The R-Square value is 0.615 which indicates that 61.45% of the total variation in the dependent variable is described by independent variables. Based on the findings, the hypothesis of negative effect of DR on EC in accepted in both long as well as short run relationship. The hypothesis of GCF and OPN reject the null hypothesis as both the variables have insignificant positive and negative effect on EG respectively in both short and long run ARDL results. While hypothesis of SR accept the null hypothesis of having positive significant effect on EG in long run while in short run it has insignificant positive effect on EG and contradicts with the hypothesis derived from literature.

The cumulative sum of recursive residual (CUSUM) presented in (Figure 4.6a) and the sum of squares of recursive residual (CUSUM of squares) explained in (Figure 4.6b) were tested in order to check the stability of the coefficients used in the model. The statistics results were graphically plotted with in two lines which lies in the area of 5% significance level. The null hypothesis is that the parameters are stable if it lies within the lines at 5% significance. If any point crosses the line beyond 5% level, the null hypothesis is rejected of stable parameters. The figures confirms that the ARDL model is stable as both statistical plots are well within 5% confidence level.

Figure. 4.6a: Cumulative Sum of Recursive Residual

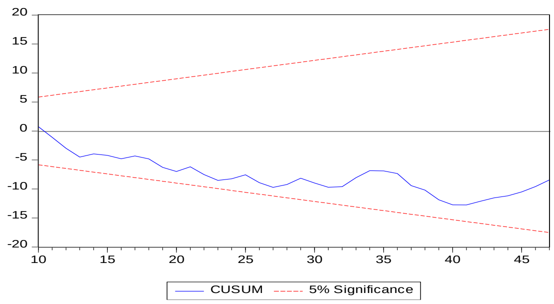
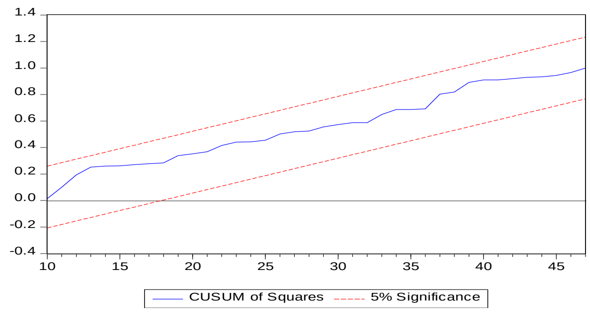


Figure. 4.6b Sum of Squares of Recursive Residual



5 CONCLUSION

In this study, the effect of population changes and capital on economic growth is assessed in the perspective of Neo-classical growth theory in Pakistan for the period of 1972-2018 after the separation of East Pakistan, now called Bangladesh. Following the contemporary trend, dependency ratio and gross capital formation and other control variables (Saving rate and Trade openness) effects are evaluated with GDP growth with better time series technique i.e. ARDL method for cointegration. ARDL model shows that Dependency ratio has a negative impact on economy of Pakistan in the long run as well as for the shorter period supporting the characteristics of neo-classical growth theory. While gross capital formation has insignificant but positive effect on economic growth. Based on the model fitness statistics, we can argue that this estimate is robust and reliable compared to the estimates given by other methods. In the light of empirical results it is carefully suggested that the government of Pakistan should take steps to reduced dependency ratios that can affect per capita output through several intermediate channels, such as by facilitating increased savings and investment at both micro and macro levels.

At the micro level, parents with fewer dependent children can more readily afford productive investments. At the macro level, resources otherwise needed to support an increasing population can be put directly to productive investments. Another channel is through improving the quality of human capital, since fewer resources are required to meet the demands for more schools, teachers, and so on. A third channel is through improved health: having fewer children results in physically and mentally stronger children, which ultimately allows them to become productive adults. All these effects can, under the right circumstances, be large and important. Furthermore, it was established from the result of the study that capital formation has no significant positive impact on the growth of Pakistan's economy within the period investigated. Based on the findings and policy implications, the study makes the following recommendations;

There should be a deliberate collaboration between the government and the private sector towards building conducive enabling environment that promotes capital investment in the economy. There should be conscious effort by both government and private sector to address the issue of corruption in the economy in addition to strengthening public statistical bodies to ensure that all private investments are captured and regulated. They further attributed the poor outcome of gross capital formation in the economy to endemic corruption in the public sector leading to over inflation of capital investments.

Overall, the study acknowledges the limitations and the complexity of dependency ratio model by using the total dependency ratio which includes both children dependent population as well as old age dependent population. For future work, dependency ratio impact on economy of Pakistan should be measured by separating the dependent population into two separate parts. i.e. Old age dependent population and young age dependent population in order to capture the effect of dependent population that whether old age dependent population is responsible for high dependency ratio or young age dependent population is the driving factor of increasing the dependency ratio which leads to lower the economic growth of Pakistan. The economic growth decisions under circumstances of high dependency ratio and lower capital stock are dangerous for government policy makers to maintain higher economic growth in the country like Pakistan. For policymakers, this study is expected to be better understood by the demographers and government to implement better policies related to reduce dependent population to improve the economy.

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