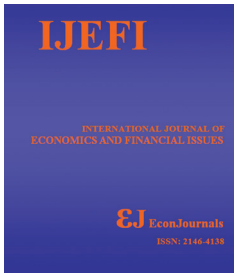

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# Nexus between Economic Growth, Health, and Education in Pakistan: An ARDL Bound Testing Approach

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**ABSTRACT**

The main theme of this research is to determine the ramification of investment on the human that is health and education on economic activities in Pakistan. The nature of figurative data is time series that is used for statistical measures which is spanning from 1971 to 2017. The econometric technique used to gauge the linkages between the above variable is the ARDL approach. Another technique called the Granger Causality has been employed to determine the regulation of effect in variables under consideration. While two diagnostic measures were used. The results depict that better health has implications on GDP while there exists convergence from short period to longer span. While empirical results show that economic growth gets more affected by education in a shorter period as compared to a longer period. RAMSEY RESET test revealed that this model was free of any misspecification and recursive measure also confirmed the same for this study.

**Keywords:** Economic Growth, Health, Education, ARDL, Pakistan
**JEL Classifications:** I10, I15, I25

## 1. INTRODUCTION

Economic growth is a vital element of any economy that is under a lot of discussion. Every economy is somehow devising means to enhance its economic growth over the period. Because there are numerous elements that either directly or indirectly influence the rate of growth, apart from economic variables, economists have started to believe that not only macroeconomic variables are vital for consistent and sustainable growth but there is a great stress to be laid upon human capital, for instance, health and education as well. An economy having healthy and educated people would be able to thrive more than an economy where people do not reach the standards of being healthy and educated.

Improved health and economic prosperity have a symbiotic link. Studies have proven that investing in human capital can improve the GDP and per capita GDP in an economy which leads towards bringing efficiency in the productivity of the economy not only this but also positively impacts the accumulation of resources and technological change. According to research conducted in Britain considering the period between 1790 and 1980, which reflected that 1/3 share of the total GDP of Britain became possible due to investment upon health which included improving the infrastructure of health care facilities and especially nutrition of the general population. It reflects that better health resulted in the technological advancement of the labor ultimately leading towards better economic growth (Fogel, 1994).

Education plays an important role in making citizens an important element in economic activities. Education provides information and technical skills in the workplace as well as the general population which results in increased economic growth. In general, education has an impact on the economic growth and development of an economy because it is regarded as a major factor in increasing human capital (Kakar, 2011).

Using the ARDL technique, this study sought to determine if there is a long-term association between economic growth, healthcare,

and learning in Pakistan. In addition to that, we have utilized the Granger Causality Test that is done to evaluate the cause and effect among the variables being used in this study. For the selection of optimal lag length criteria, the Vector Autoregressive model is employed. Furthermore, for diagnostic measures RAMSEY RESET test, CUSUM and CUSUMSQ have been used to identify any model misspecification. Long-run analysis of the above-stated variables would determine how significantly these two can play part in making the economic growth better in Pakistan.

This research is divided into six portions, the first of which is the article's introduction, followed by the second section that reviews existing literature regarding the study, in third section methodology and variables are explained, the fourth one is about the empirical results. The fifth section is about the discussion of results in the light of existing literature followed by the last section of this research which discusses the conclusion of this study.

## 2. LITERATURE REVIEW

According to one study, there is a direct relationship between health and socio-economic growth, with the adulthood rate of survival serving as a benchmark for healthcare. There are the same implications upon the growth rate when the survival rate was replaced by life expectancy. While on the other hand, using the fertility rate as an indicator of health projected negative results upon economic growth. Since we know that a high fertility rate means rapid addition into the population which stresses the already scarce resources. With increasing population, the share of resources for each person decreases hence economic growth decreasing (Bhargava, 2001).

According to a study conducted in Latin America where the measure for health selected was the likelihood of surviving for both genders belonging to different age groups. The empirical approach used for this study was the granger causality test which reflected that health improvement made economic growth better. It was observed that the annual income of adults increased from 0.8% to 1.5% in Latin America because of better health conditions. An important highlight of this study was that the better health status of females had more impact upon the economic growth as compared to males (Mayer, 2001).

Another study that used the 2SLS approach for empirical analysis, a project that life expectancy and education positively affected the GDP. Better health conditions of individuals in an economy not only significantly improve productivity but also enhances capital accumulation. The study concluded that one year increase in the life expectancy of a population increases output up to 4% (Bloom, 2004).

In the top 10 industrial countries where different groups of age were considered, and the index used for measuring the health status was life expectancy. Empirical results showed that better health conditions accounted for 30-40% improvement in economic growth. As compared to developing countries one of the major reasons for poor economic growth was declared to be poor health conditions of the general population and ill-equipped health facilities (Arora, 2001).

In another study about the effect of human wellbeing in terms of health on productivity expansion, the adult rate of death was employed as a measure for health. Empirical outcomes showed that due to an increased mortality rate, there is a probability of sluggishness being produced in economic growth. Because a lower mortality rate reduces the productive time of a human. On the other hand, empirical results reflected that spending on human capital results in positive impacts upon economic growth (Lorentzen, 2005).

Since health is treated as an output while there is a counterargument regarding this statement. The statement says that health status should be perceived as an input. A study found out that after empirical analysis of health and economic growth the elasticity between spending on the health care system and GDP turned out to be one. This indicates that if economic growth accelerates, the chances of spending upon health increases in the same manner. The research concluded that spending of developed countries on health care systems is significantly higher than developing countries due to the above-mentioned logic (Piabuo, 2017).

A study investigated the influence of healthcare spending on economic output and illustrated how the effectiveness of healthcare spending varies depending on a country's healthcare system and income level. The study also inflicted that expenditure on the health care system favors especially two groups which are middle to low earning income group. Increasing healthcare spending should be a substantial component of national consumption for these categories (Hyun-Jae, 2014).

While considering the case of Turkey where the impact of health and economic growth was studied. Bringing Feder-Ram model in utilization for this research, the results inflicted that good health conditions have positive correspondence on economic growth. Economic growth tended to increase with better health conditions. A key thing to mention here about the impact is that economic growth in Turkey displayed an uptrend while there was direct spending on health care while the effects were displayed negatively when expenditure was done in an indirect manner (Kurt, 2015).

ARDL approach was used in the case of Singapore while gauging the relationship between economic growth and health status. The empirical results projected that there existed a significant nexus of economic productivity and wellness of humans in a longer span. Furthermore, the T-Y Granger causality test estimates that health capital has a one-way causal relationship with economic growth. It indicates the fact that increasing per capita health expenditure will raise GDP per capita (Akingba, 2018).

Tallinn (2006), examines the economic costs of poor health as well as the economic advantages of improving it for Estonia using adult fatality rates, birth rates, and life span. According to the findings of the study, the reproduction rate and rate of mortality have a negative and significant effect on the OLS, and Fixed effect parameter estimates used for empirical analysis. Moreover, the study also indicates, using data collected, that poor health has a negative as well as a statistically significant impact on the supply of workers and output on an individual basis.

According to Zon (2001), excellent health is a mandatory trait for people being able to give services. According to the study, a surge in demand for health services older population will have a major adverse effect on economic growth.

According to Gyimah-Brempong (2004), expenditure and portfolio of wellness social resources have a robust and inverse relationship with per capita income increase. This association, meanwhile, is exponential. According to the report, investing in healthcare in LDCs will increase access to health, which will promote economic growth in the near term and raise economic status in the long term.

Sachs (1997) discovers that human capital in healthcare has a quadratic relationship with the growth of economic growth by utilizing average lifespan as an indicator of wellness. This research reflects that healthy human capital improves growth in the economy at a diminishing pace.

Using the 2-Stage Least Square approach, Malik (2005) examined health status by mortality rate, child mortality, and per person Gross Domestic Income as a proxy for economic growth. The results proved that health outcomes have a positive effect on growth.

Barro (2013) investigated the role of healthcare in growth in the economy. He evaluated men's overall survival at 15 and 60 years old and discovered that around 11% of the increase is due to greater wellness, concluding that investment in investments in human capital, particularly in healthcare and education, plays an essential role in stimulating the economy.

Using various human capital indicators for health care and education, determined that wellness has a favorable impact on growth. According to the research, a one-year rise in general average lifespan leads to a 4% increase in income. This suggests that increasing funding for health care is reasonable (David and David, 2001).

Finlay (2006) concluded that health wellbeing plays a critical part in the process of economic growth following a study on the impact of health on economic growth using 3 separate methodologies. These three approaches are direct output per worker effect, significant interaction, and inducement effect. Various substitutes were employed. The study's findings revealed that there is a link between good health and economic success, and that focus on health has a beneficial impact on both growths in the economy and education.

Using panel data from 1965 to 2000, a study analyzed the nexus between economic growth and East Asian countries. The proxy used for education to measure the human capital was schooling years. The study utilized the "Labor Augmented Solow Model" and results affirmed that education displayed a significant impact upon economic growth (Permani, 2008).

Considering the case of Caribbean nations to check the link between education and economic development. For this study vector error correction method was employed on data taken from 1964 to 1998. The empirical findings were that in the short run income and education had a causing relationship. While in Trinidad and Tobago in both the short-run and long-run no relationship was found. The research advocated for higher spending on the education sector for implications on economic growth and (Francis and Iyare,2006).

The nexus between economic activity and education in Pakistan was explored using the ARDL cointegration approach using time series data. The results inflicted that in short there existed a two-way inverse linkage between education and economic growth. On the other hand, in the long run, a direct relationship was formed between the above-said variables. This study suggested lowering inflation and poverty can make exponential growth in education and economic growth (Afzal, 2013).

Another study used Johansen cointegration approaches in a VAR framework and casualty approach over time series data ranging from 1972 to 2005 while considering the case of Pakistan. The analytical findings demonstrated that, in the long haul, there was a link between school enrollment and the rate of economic growth. The results of the casualty analysis verified the one-way causality that went from economic growth to education in Pakistan (Chaudhary, 2009).

A study was done on six Gulf countries to gauge the correspondence between better education opportunities and economic activity. The author assumed that investment in education is extremely important. In boosting the growth of economic activities in any economy. Spending on human capital is critical to the growth of any country's economy. The human capital should also be considered as an input just like any other input which is considered in factors of production. The findings demonstrated that each country's causes for economic growth are unique, and it is possible that empirical results may not show significance when effects are being gauged between economic growth and human capital (Al-Yousif, 2008).

A similar study was conducted in New Zealand that discovered a substantial correlation between economic growth and education throughout the 1990s. Before the implementation of "Knowledge Wave1," the economic development of New Zealand and living conditions were deteriorating. With the inclusion of effective policies for education and continuous funds being released for educational purposes in New Zealand, an increase of 6 percent in economic growth was witnessed (Khan and Bashar, 2015).

In the case of Nigeria, two econometric approaches were used to determine the connection between social development and economic expansion. The two approaches included Johansson co-integration technique and the vector-error correction. The results proved that education impacts long-term income prosperity. The findings of co-integration results concluded that enrolment of children at primary and tertiary level are likely to improve the productivity hence the economic growth. The results of Vector Error Correction (VEC) indicated that a labor force that has better education maneuvers economic growth in a significant manner (Adelakun, 2011).

A study was done by keeping into consideration both developed and underdeveloped countries. The result revealed that there existed inconsistency at different levels of enrolment in education institutes. This study was done by using panel data by considering both groups of countries and a single cross-section was developed for this purpose to explore the linkages between the rate of economic growth and education. The research concluded that in both countries' education can increase economic growth. Investing in education has a favorable impact on the economy (Mankiw, 1992).

Another research investigated the link involving educational expansion and economic growth. The method employed for this research was controlling for concurrent causality with endogeneity methodologies. The results projected that the outcome of spending on public education turns out to be around 20% (Barro, 1991).

Several studies have been conducted in the past which used panel data to identify the possible effect of education upon economic growth. Several of this research, employing panel data, failed to discover any empirical relationship between schooling and economic growth. During the comparisons of the model which used as an input, consider human capital in the cause of production and models which associated human capital with the acquisition of knowledge or skill learning. In the secondary model, human capital is taken up as an intermediate input factor towards production. The former implies a connection between economic growth and technological growth, while the latter suggests a connection between economic growth and the mean amount of human capital per worker. The results from empirical findings suggest that the latter model is more suitable for such kinds of studies. Since a labor force that is equipped with the knowledge, skills, and education tends to perform better in terms of economic growth. In addition to that, it also possesses the ability to easily adapt to changing and new trends (Benhabib, 1994).

Another study examined the influence of schooling on EG in Pakistan from 1973 to 2001. They used the Levine Renelt technique to investigate the potential influence of schooling on GDP. The findings of their investigation demonstrate that education has a tremendous impact on economic prosperity. Saving and investing in the health and education sectors can help to develop human capital (Stengos, 2008).

In Bangladesh, a study corroborated the findings of bidirectional causality between schooling and EG (Wadud, 2007). Furthermore, another study looked into the relationship between schooling and EG in China. In an analysis of a similar study, he used cointegration and Granger causality techniques. The findings revealed that EG was the cause of primary education. Higher education, on the other hand, was the cause of EG. In this study, there is no cointegration between schooling and EG (Huang, 2009).

Katircioglu (2009) investigated in North Cyprus the long-run connection and the causality of university education and economic productivity. In his investigation, the cointegration and Granger causality tests were utilized by the author. The findings of this study revealed that there was an LR link between schooling and EG. A unidirectional causal relationship was also discovered, which ran from higher learning to EG. The concept of higher education-led growth is advocated for the Turkish Cypriot economy.

Using a growth accounting paradigm, Abbas (2000) held a comparison of two countries from South Asia which were Pakistan and India on the significance of spending on human wellbeing in income progress from 1970 to 1994. He carried out this research which is divided into two stages. In the first step, he investigated the impact of education on economic progress. Secondly, he coupled primary, middle, and tertiary education with occupation to investigate productive labor inputs. The study's findings found that human resource indices such as education at various levels, when coupled with labor, have a substantial and positive impact on economic growth.

Abbas (2001) examines the impact of macroeconomic variables in Pakistan and Sri Lanka using school enrollment data. According to the study, intermediate and upper participation rates have a strong effect on economic development in both countries, however, basic participation rates have a negative effect. The author blended varied levels of enrollment rates with employment to create an effective labor force input. According to the study, a productive labor force has a large and favorable effect on economic development. According to the survey, spending upon humans for their betterment and wellbeing is absolutely necessary to achieve better economic growth.

Abbas (2007) assess the impact of human resources on Pakistan's economic growth from 1963 to 2003 using Engle-Granger cointegration. They employed intermediate participation as a substitute as a proxy for wellness, for educational, and for state healthcare expenditures. According to the analysis, boosting investment in the medical field boosts both human and physical capital.

Madsen (2008) investigated Indian growth from 1950 to 2005, as well as a dataset of 590 Indian enterprises from 1993 to 2005, to identify spontaneous growth in India. Estimation with an expanded human development production factor was done using cointegration. The analysis discovered that there are no long-run connections between overall factor efficiency and scientific effort.

## 3. DATA AND METHODOLOGY

For this study, a total of six variables are used, which include one dependent variable and five independent variables. The list of variables, including the reference of their data is given in the Table 1 presented below:

This study covered the period between 1971 and 2017 for empirical analysis for all variables. A dependent variable in this research is economic growth and the proxy used for it is GDP. The values for the GDP of Pakistan are according to the current value of the US dollar. The interpretation for life expectancy is the expected life of a human being at the time of birth in Pakistan. While mortality rate reflects the rate of mortality considering newly born and the fertility rate tells us about the average number of births per woman in Pakistan. The indicators used for education are secondary

**Table 1: Data source**

| Variables | Source |
|---|---|
| GDP | WDI |
| Life expectancy | WDI |
| Mortality rate | WDI |
| Fertility rate | WDI |
| Secondary enrollment | WDI |
| Expenditure on education | WDI |

enrollment and government spending on education, it is a gross percentage of enrollment and percentage of GDP being spent on education respectively.

Hence the equation for the above-stated variables become as follows:

$$\text{Ln GDP} = \beta_\circ + \beta_1 \text{ LE} + \beta_2 \text{ MR} + \beta_3 \text{ FR} + \beta_4 \text{ EE} + \beta_5 \text{ SE} + \varepsilon \quad (1)$$

### 3.1. Auto-Regressive Distributed Lag (ARDL) Approach

In this study, the econometric approach used for statistical measures is ARDL to cointegration devised by (Pesaran, 2001). The ARDL model or the bounds test approach to cointegration is appropriate irrespective of the sequence of integration of the variables employed in an empirical study. However, the existence of cointegration at the second level must be assured to circumvent erroneous outcomes or collapse of the ARDL operation. There are many other techniques to gauge the co-integration of variables like Engle (1987), Johansen (1990), etc. The issue faced while employing these approaches is that lower power and non-stationarity of variables may fail empirical analysis. In addition to that these approaches do not perform well, data containing not many values. In this matter, the ARDL approach is a better technique to perform co-integration analysis. Moreover, it can also deal with the problem of endogeneity. ARDL approach is viable in analyzing plenty of variables at the same time plus it gives significant results while using a smaller data set. The general form of the ARDL approach is stated below

$$y_t = \beta_0 + \beta_1 y_{t-1} + \ldots + \beta_p y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \ldots + \alpha_q x_{t-q} + \varepsilon_t$$

The error term is denoted by $\varepsilon_t$, $\beta_0$ is an intercept, and $y_{t-1}$ shows the lags in the model.

Following the empirical work of (Boachie, 2017) and (Afzal, 2013). Converting the above model (1) into ARDL form

$$\Delta LnGDP_t = \alpha + \sum_{i=1}^{n1} \beta_1 \Delta LnGDP_{t-1\,i} + \sum_{i=0}^{n2} \beta_2 \Delta LE_{t-1} + \sum_{i=0}^{n3} \beta_3 \Delta MR_{t-1}$$
$$+ \sum_{i=0}^{n4} \beta_4 FR_{t-1} + \sum_{i=0}^{n5} \beta_5 EE_{t-1} + \sum_{i=0}^{n6} \beta_6 SE_{t-1} + \rho_0 LnMd_{t-1} + \rho_1 LnEA_{t-1}$$
$$+ \rho_2 LnInt_{t-1} + \rho_3 LnEU_{t-1} + \rho_4 LnPU_{t-1} + \varepsilon_t$$

Since stationarity of variables is the first condition of successfully running an ARDL approach. For demonstration and ensuring the stationarity in the data of variables at a different level, we have utilized Augmented Dickey-Fuller Test (ADF). To test for any misspecifications in this model, we have used the RAMSEY RESET test and Recursive measures.

### 3.2. Granger Causality Test

In this study, another approach is applied to gauge the causal relationship between variables. This research has followed the approach presented by (Yusoff, 2015) and developed by (Granger, 1969). To determine the causal relationship between all variables, the Granger causality test is used. According to this approach, one variable tends to granger cause the other variable if the past values of a variable help to predict the future outcomes of the other variables. This model is also popular since it enables to find of the direction of effects without much work to be done. For lag order selection criteria VAR is utilized. The general form of Granger causality is given below

$$Y_t = \varphi_\circ + \sum_{i=1}^{p} \delta_i Y_{t-1} + \sum_{j=1}^{p} \alpha_j X_{t-j} + \varepsilon_{1t}$$

$$X_t = \gamma_\circ + \sum_{i=1}^{q} \chi_i X_{t-1} + \sum_{j=1}^{q} \beta_j Y_{t-j} + \varepsilon_{2t}$$

P and q mentioned in the above equations account for lag observation implied in the model. While the error terms $\varepsilon_{1t}$ and $\varepsilon_{2t}$ of which the variance is made to decrease with the increase of input values in the above equation then we can state that there is causality between variables either from y to x or x to y.

### 3.3. Vector Autoregression (VAR)

To determine the optimal lag length for granger causality we adopted VAR. Vector Autoregression has the ability to gauge the relationship between more than one variable since the values change with the passage of time. The general form of the model is given below:

$$Y_t = \alpha + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + \varepsilon_t$$

## 4. EMPIRICAL ANALYSIS

### 4.1. Unit Root Test

While using the ARDL approach for empirical analysis, in the beginning, to verify for stationarity of variables, a unit root test is implied. The stationarity of variables is important to avoid any malfunction of the ARDL approach. The following Table 2 displays the results for the unit root test. The standard Augmented Dickey-Fuller Test is used to test unit root.

All the variables were found stationary at the first difference on different significance levels as shown above except the fertility rate which is reported to be stationary at level. Hence the first condition for the ARDL model is satisfied consequently we can move on with the rest of the empirical analysis.

### 4.2. ARDL Bound Test

To test long term relationship between the variables, we have used the bound technique. Bound testing is necessary which is a testimony projecting the probability of long terms relationships

among the variables. Creating a null hypothesis that there is no long-run relationship. The outcomes of the Bound test are presented in the Table 3 below:

The approach for determining the long-term link between variables is done by comparing the values of F-statistics and critical bound values. The significance level here under consideration is 5 percent. For the presence of long-term linkages, the value of F-statistics needs to be greater than the critical bound value at both the first difference and level. Here in this case the F-stats value is exceeding all critical bound values. We can state that there exists a long-term nexus between GDP, life expectancy, mortality rate, fertility rate, spending of government on educational purposes, and secondary enrolment in Pakistan. By large the estimates of the ARDL approach are pretty much significant.

## 4.3. Long Run Coefficients

Since cointegration between economic growth and all other variables has been reported previously. We can now move on to report the long-term coefficients of the ARDL approach. The empirical results of long-run estimation (ARDL 7, 4, 4, 1, 2, 4) is reported in the following Table 4:

From the above-reported results, it is evident that four out of five independent variables have shown significance at a different level of significance. Life expectance, mortality rate, and fertility rate turned out to be significant at a 1% level of significance. While expenditure on education remained significant at a 5% level of significance. Secondary Enrollment is the only variable that did not report any significance in long-run estimation.

## 4.4. Short Run Estimates

The next step in empirical findings is to report the short-run analysis and gauge the effect of any shock upon the variables in the short run. To estimate the short-run results Error Correction Form (ECM) is employed. The results of the short run are reported in the following Table 5:

The negative value of constant for Error Correction Model (ECM) turned out to be negative and significant at a 1% level of significance. This implies that there exists integration from the short to the long term in the case of Pakistan. The constant of ECM suggests that 5% of the GDP of Pakistan aligns from short run to long run keeping into consideration all the independent variables.

## 4.5. Vector Autoregression Model (VAR)

The purpose of employing vector autoregression in this scenario is to determine the optimal lag length. The optimal lag length, in this case, is 3. The results of VAR are reported below in Table 6:

## 4.6. Granger Causality Test

In this research, the pair-wise Granger causality test is utilized to evaluate the cause and effect among variables. In each of the results for pair-wise Granger causality, we first develop a hypothesis that under consideration variables do not cause each other while test it using the statistic measure. If statistics are significant then we

**Table 2: ADF**

| Augmented Dickey-Fuller test | | | |
|---|---|---|---|
| **Variable** | **At level** | **First difference** | **Decision** |
| LnGDP | 1.0000 | 0.0001*** | I (1) |
| Life Expectancy | 0.3320 | 0.0097** | I (1) |
| Mortality Rate | 0.5967 | 0.0941* | I (1) |
| Fertility Rate | 0.0000*** | 0.0029 | I (0) |
| Government Expenditure on Education | 0.0270 | 0.0009*** | I (1) |
| Secondary Enrolment | 0.9275 | 0.0114* | I (1) |

*Shows significance at 10%. **Shows significance at 5%. *** Shows significance at 1%

**Table 3: Bound test**

| Null hypothesis: No long-run relationships exist | | |
|---|---|---|
| **Test statistics** | **Value** | **K** |
| F- Statistics | 5.086736 | 5 |
| **Critical value bounds** | | |
| **Significance** | **I (0)** | **I (1)** |
| 10% | 2.08 | 3 |
| 5% | 2.39 | 3.38 |
| 2.5% | 2.7 | 3.73 |
| 1% | 3.06 | 4.15 |

**Table 4: Coefficients of estimated ARDL model**

| Variable | Coefficient | Standard error | T-statistic | P-value |
|---|---|---|---|---|
| Life expectancy | 0.768428 | 0.069019 | 11.13352 | 0.0000*** |
| Mortality rate | 0.144378 | 0.018098 | 7.977464 | 0.0000*** |
| Fertility rate | −1.249893 | 0.150944 | −8.280506 | 0.0000*** |
| Expenditure on education | −0.050699 | 0.015090 | −3.359849 | 0.0057** |
| Secondary enrolment | −0.001785 | 0.002186 | −0.816441 | 0.4302 |
| Constant | −28.39152 | 5.210640 | −5.448759 | 0.0001*** |

*Shows significance at 10%. **Shows significance at 5%. ***Shows significance at 1%

**Table 5: Error correction representation of ARDL model**

| Variable | Coefficient | Standard error | T-statistic | P-value |
|---|---|---|---|---|
| $\Delta LnGDP_{t-1}$ | 3.579400 | 0.554603 | 6.453987 | 0.0000*** |
| $\Delta LnGDP_{t-2}$ | 2.620472 | 0.448722 | 5.839854 | 0.0001*** |
| $\Delta LnGDP_{t-3}$ | 1.843397 | 0.323764 | 5.693640 | 0.0001*** |
| $\Delta LnGDP_{t-4}$ | 1.079646 | 0.202623 | 5.328361 | 0.0002*** |
| $\Delta LnGDP_{t-5}$ | 0.335606 | 0.086692 | 3.871237 | 0.0022*** |
| $\Delta LnGDP_{t-6}$ | 0.128591 | 0.054420 | 2.362946 | 0.0359** |
| $\Delta LE_{t}$ | −14.18009 | 2.748320 | −5.159547 | 0.0002*** |
| $\Delta LE_{t-1}$ | 14.84843 | 5.414758 | 2.742215 | 0.0179** |
| $\Delta LE_{t-2}$ | −2.276586 | 5.436827 | −0.418734 | 0.6828 |
| $\Delta LE_{t-3}$ | −23.83803 | 5.366442 | −4.442055 | 0.0008*** |
| $\Delta MR_{t}$ | −0.283974 | 0.078228 | −3.630063 | 0.0035** |
| $\Delta MR_{t-1}$ | −0.768791 | 0.167852 | −4.580168 | 0.0006*** |
| $\Delta MR_{t-2}$ | −0.420399 | 0.125091 | −3.360744 | 0.0057** |
| $\Delta MR_{t-3}$ | −0.244943 | 0.104312 | −2.348188 | 0.0368** |
| $\Delta FR_{t}$ | 5.514467 | 1.445240 | 3.815608 | 0.0025*** |
| $\Delta EE_{t}$ | −0.209070 | 0.028102 | −7.439768 | 0.0000*** |
| $\Delta EE_{t-1}$ | 0.082019 | 0.033712 | 2.432931 | 0.0316** |
| $\Delta SE_{t}$ | −0.007266 | 0.005628 | −1.291058 | 0.2210 |
| $\Delta SE_{t-1}$ | 0.013582 | 0.005689 | 2.387173 | 0.0343** |
| $\Delta SE_{t-2}$ | −0.003761 | 0.005556 | −0.676986 | 0.5113 |
| $\Delta SE_{t-3}$ | −0.014655 | 0.005502 | −2.663620 | 0.0207** |
| $ECM_{t}(-1)$ | −5.175542 | 0.708177 | −7.308264 | 0.0000*** |

*Shows significance at 10%. **Shows significance at 5%. ***Shows significance at 1%

would state that hypothesis is rejected and there exists a causal relationship. The results of which are given below:

From the above results of Table 7, it is evident that there is causality between life expectancy and economic growth and the direction of this causality goes from life expectancy towards economic growth since it is significant at a 10% level of significance. There exists unidirectional causality from life expectancy to GDP.

As it is clear from the above results of Table 8 that statistical values of both hypotheses are significant at a 1% level of significance hence, we reject the null hypothesis. We can confidently state that there exists two-way causality between mortality rate and GDP in Pakistan.

There is a one-way causality that runs from fertility rate to GDP in Pakistan due to statistical significance. While on the other hand, we accept the null hypothesis that GDP does not granger cause a fertility rate due to statistical insignificance. The results are reported in Table 9.

There is no evidence of a causal relationship according to results reported in Table 10 between secondary enrolment and GDP according to the above results reported. Hence, we accept the null hypothesis in both cases.

From the above results of Table 11, we can accept the null hypothesis in both cases due to statistical insignificance, and no causal relationship between the variables is reported.

### 4.7. Diagnostic Measures

To confirm this model to be free from any sort of misspecification, we used two-measure given below

- RAMSEY RESET Test
- Recursive measures.

The results of both are given are below

To check any misspecification in the model using the RAMSEY RESET test, both values of T-statistics and F-statistics need to be insignificant. As is evident from the above results in Table 12 that both these values are insignificant at a 5% level of significance, we can state that this model is correctly specified.

Moving onto the second diagnostic measure that is the recursive measure, the graph of CUSUM and CUSUMSQ are reported below:

It is considered useful to check for model specifications to get significant results. For this many econometricians like Pesaran (1997), Brown (1975) has recommended the use of CUSUM and CUSUMSQ. In Figures 1 and 2 CUSUM and CUSUMSQ both report stability at a 5% significance level. Overall, these diagnostics reinforce the validity of our short-run and long-run estimates. CUSUM graph given above supports our results about the functional form about its specification at a 5% level of significance. These figures also demonstrate the consistency of long-run and short-run estimations based on the literature. Graphs are plotted via the sample size, two straight lines (red) show the critical value. As long the CUSUM lies within them, stability is reported.

## 5. DISCUSSION

This research analyzed the possible effects of health and education on Pakistan's economic growth. Different indicators are used to assess the effects of both education and health in this research. The findings demonstrated a long-term link between health and education. Both of these human capitals have the potential to boost economic activity.

From the results, we found out that increased life expectancy and controlled mortality rate tend to positively affect Pakistan's economic growth both in the short and long run. While on the other hand increased fertility rate negatively affects economic growth and positively affects the economy in the short run. It is evident to state that a healthier population contributes significantly to economic productivity. One year added in life expectancy at birth can potentially enhance the GDP by 70% in Pakistan. Which clearly shows the magnitude of better health on economic productivity. Taking into consideration the mortality rates the results state that controlled mortality has the potential to contribute towards economic growth. The magnitude of the effect of the mortality rate accounts for 14% of the GDP of Pakistan. Again, it shows how vital expenditure on health can prove in Pakistan. Discussing the last indicator for health, the empirical finding shows that the fertility rate negatively impacts economic growth in Pakistan. One additional birth to a woman decreases 12% of economic growth. As indicated by Sher Ali, (2013) in his research regarding the population growth in Pakistan, in the short run the fertility rate has a positive effect upon economic growth while negative in the longer span of time. This is because in the short run there is an increase in the labor force but in the long run, due to lack of education, this additional labor force negatively impacts the economic growth. This makes sense since resources are already scarce and additional birth decreases per share of a human being according to this study. A similar study was conducted by Chaudhry (2013) emphasized the outcomes of better health conditions in Pakistan. The author also recommended

**Table 6: VAR**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | −251.4620 | NA | 0.004871 | 11.70282 | 11.94612 | 11.79305 |
| 1 | 324.6484 | 968.9129 | 1.08*e* | −12.84765 | −11.14456 | −12.21607 |
| 2 | 536.2794 | 298.2074 | 4.03*e* | −20.83088 | −17.66800 | −19.65793 |
| 3 | 628.5505 | 104.8535* | 4.03*e** | −23.38866* | −18.76599* | −21.67435* |

*Indicates lag order selected by the criterion. LR: Sequential Modified LR Test Statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quin information criterion

**Table 7: Causality between GDP and LE**

| Null hypothesis | F-statistics | P-value |
|---|---|---|
| LE does not Granger Cause LnGDP | 1.75399 | 0.1029* |
| LnGDP does not Granger Cause LE | 0.03144 | 0.9924 |

* 10% level of significance. LE: Life expectancy

**Table 8: Causality between GDP and MR**

| Null hypothesis | F-statistics | P-value |
|---|---|---|
| MR does not Granger Cause LnGDP | 9.74410 | 0.0000*** |
| LnGDP does not Granger Cause MR | 9.79369 | 0.0000*** |

***1% level of significance. MR: Mortality rate

**Table 9: Causality between GDP and FR**

| Null hypothesis | F-statistics | P-value |
|---|---|---|
| FR does not Granger Cause LnGDP | 7.54984 | 0.0005*** |
| LnGDP does not Granger Cause FR | 0.59953 | 0.6194 |

***1% level of Significance. FR: Fertility rate

**Table 10: Causality between GDP and SE**

| Null hypothesis | F-statistics | P-value |
|---|---|---|
| SE does not Granger Cause LnGDP | 0.67965 | 0.5701 |
| LnGDP does not Granger Cause SE | 2.60528 | 0.0663 |

SE: Secondary enrolment

**Table 11: Causality between GDP and EE**

| Null hypothesis | F-statistics | P-value |
|---|---|---|
| EE does not Granger Cause LnGDP | 1.66815 | 0.1906 |
| LnGDP does not Granger Cause EE | 0.96989 | 0.4173 |

EE: Government Expenditure on Education

**Table 12: Diagnostic test**

| RAMSEY RESET test | | |
|---|---|---|
| **Statistics** | **Value** | **Probability** |
| T-statistics | 1.071404 | 0.3069 |
| F-Statistics | 1.147906 | 0.3069 |

that the government of Pakistan should revise its budget allocation policy and work more towards developing causes of the general public. Pakistan's share of the health care system is very low. Kalim, (2012) in another study found out in Pakistan, there is a positive and long-term association between health and per capita GDP. In the reflection of different literature studied the empirical findings of health status positively impacting the economic growth in Pakistan hold significant. In addition to that, there are several studies regarding other countries like Boachie (2017) that analyzed the impact of health on economic growth in Ghana projected that better health conditions significantly and positively the Ghanian economy. In the case of Ethopia Gebrehiwot (2014) stated that health is one of the main contributors to health.

Talking about the other human capital of this study which is education in Pakistan. In long run, the government expenditure on education did not turn up to be positively affecting the economic growth. The reason for this is obvious since the population of the country is consistently on the rise and a meager share of total GDP is spared for educational purposes due to which not much of the population has a probability of getting a quality education.

**Figure 1:** Plot of ARDL CUSUM Test 1

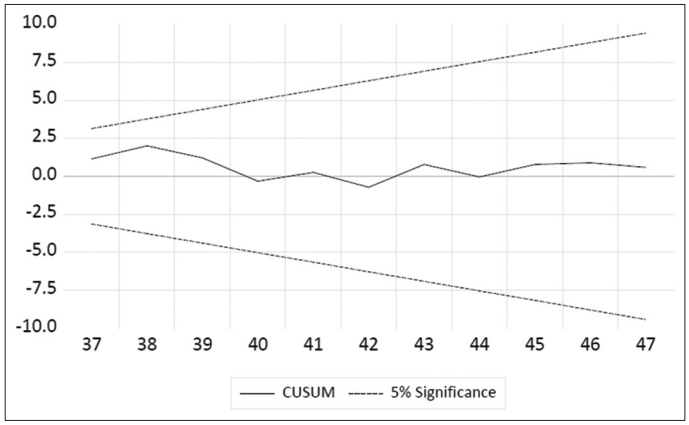
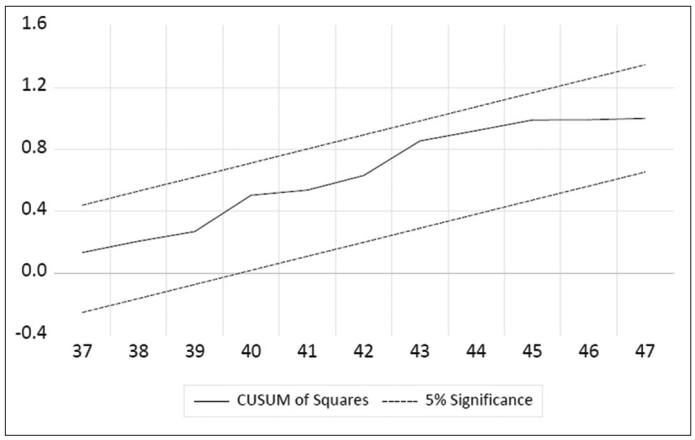



**Figure 2:** Plot of ARDL CUSUMSQ Test 1




Hence there is not much development and skill learning of labor. While on the other hand, spending in the education sector turned out to be positively impacting economic growth in the short run. As indicated by Muhammad Afzal (2013) in the case of Pakistan education does tend to positively impact the economic growth in Pakistan. The results of education spending could not be captured significantly since after the 18th amendment as depicted by Aslam (2019) that budget allocation of educational purposes is different in all the four provinces and the gross percentage of GDP does not appear to give the true impact of the education spending in Pakistan.

The second indicator of education selected for this research is secondary enrolment in Pakistan. The long-run coefficient of this indicator did not show significance but it is positively impacting the economic growth. In Pakistan, there are many different types of education going on as explained by Aslam (2019) in his research about Pakistan. The gross measure of enrollment may not reveal accurate impacts on economic growth. If the effects of enrollments in different systems of education are gauged, then there are better chances to analyze the impacts.

Spending on human capital for obvious reasons does not show results immediately but it takes time to fully capture the effects of such investments. For this purpose, we employed the granger causality approach to see the effect of education and health of lagged values in the recent period. The results of this approach

show that causality exists only between the indicators of health and no causal relationship between the proxies of education and economic growth was witnessed in the findings section of this study. The results of Granger causality are pretty much aligned with the ARDL approach which displayed a substantial effect of health on GDP and negligible in the case of education.

Reflecting on the results of Granger causality for each pair reported earlier, it is evident that if a person tends to live more it will have more years to remain active in the economic activities consequently it can contribute more towards the national economic progress. While on the other hand fertility rate is causing economic growth which means that more births can increase economic progress as captured earlier in the cointegration results having positive effects on fertility in the short-run and negative in the long run. A similar sort of situation is being projected in the causal relationship.

Getting insights about the last indicator of health being the mortality rate, tends to cause economic growth and get caused by GDP. It simply means that an improved mortality rate can affect the GDP while on the other hand GDP can also be critical in making the mortality rate better.

Discussing the causal relationship of education and economic growth, no effects were captured either way among the variables of education in Pakistan. This could imply that education spending does not appear to have a substantial impact on the country's economic growth. Such a minor outcome may imply that spending on education will be delayed to provide the projected benefit in economic growth (Yusoff, 2015). Such results are expected to be aligned with the empirical investigation of Baldacci (2003), It indicated that there can be considerable gaps in between the application of social programs in the education advances in some of these domains As a result, the authorities must modify the accountability and efficiency of state funding for education to ensure that these resources are fully utilized for economic growth.

## 6. CONCLUSION

It is critical to comprehend the effect of various factors upon the performance of overall economic activities in any country. The outcomes of human capital development as proved by plenty of literature available surely impacts economic growth. This study implies that the health of the general population can not be ignored. Pakistan can achieve a lot in terms of economic objectives by spending more on health. Since the empirical results have shown significance both in the long and short run. On the other hand, the education sector needs a bit of improvement in Pakistan because in the short run it does impact economic growth. In the long period, education did not tend to positively impact productivity in Pakistan. Serious budgetry revisions are required as well as spending upon various forms of human capital to ehance the economic progress.

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