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The Triangular Causality Among Education, Health and Economic Growth: A Time Series Analysis of Pakistan

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Abstract: The study scrutinizes the existence of long run association and triangular causality among real GDP per capita, per capita education expenditures and per capita health expenditures in Pakistan. The present study applies Ng - Perron test to investigate stationarity, ARDL bounds testing approach to examine the existence of long run relationship and Granger Causality test for estimating short run, long run and combined short run and long run triangular causality among the variables for the time series data of Pakistan from 1972 - 2009. The present study exposes that there exists long run relationship among real GDP per capita, per capita education expenditures and per capita health expenditures in Pakistan. There exists bidirectional relationship between per capita real GDP and per capita education expenditures in the short run, whereas per capita health expenditures and real GDP per capita do not granger cause each other in short run in Pakistan. Also, there exits bidirectional granger causality among real GDP per capita, per capita education expenditures and per capita health expenditures in long run in Pakistan. The present study also confirms the existence of joint causality among real GDP per capita, per capita education expenditures and per capita health expenditures in both short run and long run in Pakistan.

Key words: Real GDP per capita · Per capita education expenditures · Per capita Health Expenditures · Pakistan

INTRODUCTION

Health; economic growth and education are appeared one of the leading factors among all in Pakistan and also the fortune of roughly 180 million people of Pakistan is based on the joint and consistent improvement of these factors for a long period of time in Pakistan. It is the fact that rate of education, rate of economic growth and health standards are showing extremely deplorable performance in Pakistan since 1947. Generally speaking, low literacy rate causes narrow mindedness; intolerance, prejudice and discrimination in Pakistan. Also, low rate of economic growth is not providing opportunities to the both public and private sectors to save more; to invest more, to enlarge the size of the domestic markets, to enhance trade, to generate more capital for reinvestments, to develop infrastructure, to install industries for import substitutes and many more. Similarly, poor health standards decreases the life expectancy rate, increases the infant mortality rate and ultimately the death rate society as whole increases.

Additionally, if people do not feel healthy then they will not be able to perform their responsibilities efficiently at their offices respectively. All these three factors like health; economic growth and education are very important for the fate of the people of Pakistan; if government of the state seriously focuses on these three factors today, the results will be in front of the world in the future. The reason is that these factors have potential to reveal results in the long run. The present study prescribes that if government of the state invests in these factors today then it will mature diamonds in the future. Besides the importance of the running actors of the study; an attempt is made to see how the link among these variables is discussed by the various researchers. Krugman [1]; Young [2, 3], Morris [4], Takenaka [5], Mingat [6], Hanushek and Kimko [7], Wang and Yao [8], Fleisher [9], Lee [10], Zin [11], Kwack and Lee [12]; Milanovic [13] and Kikuchi [14] find both theoretically and empirically that development of export led industries and the accumulation of human capital in the form education raise the rate of economic growth. The World

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Bank [15] report depicts that the improvement and growth in both primary and secondary education became the reason of high rate of economic growth in East Asia during the period of 1960 to 1990s. In addition to it, Schultz [16] reveals that rate of economic growth also depends on health which is another imperative form of human capital. The literature exposes that expenditures on education and health have positive impact on the rate of economic growth in the long run but in the short run only expenditure on education has a positive relationship with rate of economic growth.

The present study considers per capita expenditures on education and health by the government of Pakistan as proxy for human capital. Mankiw *et al*. [17]; Bergheim [18] and Hewitt [19] accept the significance growth of human capital in the both endogenous and exogenous growth theories. The literature reveals substantial empirical studies on education but there are few studies on the significance of health in Pakistan. Although education and health sectors are very vital in promoting rate of economic growth for all the countries, regretfully these have never been the prime focus of all the governments who have been in powers in Pakistan since its emergence on the face of this earth. Therefore, the present study is an attempt to investigate the existence of causality among per capita real GDP, per capita education expenditures and per capita health expenditures in Pakistan for the time period of 1972 - 2009.

Apart from the Section 1 that contains introduction of the study, the remaining study is proposed as follows. Section 2 sheds light on literature review on per capita health, education and economic growth. Section 3 reveals the econometric framework and explains the data set which is used in the present empirical investigation. Section 4 spots light on the estimation results of the data set for the period of 1972 - 2009 by applying Ng - Perron test for testing stationarity, ARDL - technique for finding cointegration among the operating variables of the study and Granger Causality test for estimating existence of granger causality among the variables in the short run, in the long run and combine in short run and long run. Also this section presents the interpretation of the key findings of the study. Last but not least, section 5 offers concluding remarks and opens up the doors for policy implications.

Review of Literature: Rivera and Currais [20] found a positive and significant effect of health on income growth. The study applies Hausman test on the variables such as mortality rates or life expectancy, per capita income, health investment, time line, GDP and health expenditures and it is found that there is existence of feedback effect between health and income. Abbas [21] applies standard growth accounting methodology on Gross Domestic Product (GDP); employment, physical capital and human capital for the time period of 1970-1994. The results show that human capital represented in the form of primary schooling enrolment rates has a negative impact on economic growth for Pakistan and Sri Lanka and human capital represented in the form of secondary schooling enrolment rate shows positive and significant impact on economic growth for both countries.

Temple [22] depicts for OECD countries that in assessing the empirical evidence for productivity benefits of education, it is quite possible that an overall judgment is frequently contaminated by a keen awareness of wider benefits of education that are not captured in economic data. Education does not have to be justified solely on the basis of its effect on labor productivity.

Halvorson [23] examines that the backdrop of economic crisis in Pakistan and the growing linkages among changing livelihood systems, the feminization of agriculture and seasonality. According to the study women in the Karakoram-Himalaya remain closely tied to water- and environmental health related risks like unsafe water, inadequate sanitation and poor hygiene practices, traditional water supplies and poor drainage system. The study emphasizes that how divisions of labor, household structure and women's social status are key elements for building an understanding of the fundamental social processes underlying variations in the incidence of childhood disease.

Strulik [24] investigates that growth of the fully-fledged economy is endogenously explained by external effects of child quality expenditure on human capital of next period's work force by using general equilibrium context and discusses the consequences on macro-economic performance on variables like child health and child schooling. Papageorgiou and Sebastian [25] present an alternative specification of human capital within a standard infinite-horizon neoclassical growth model that incorporates an explicit law of motion of the mean years of education by applying Bils and Klenow [26] model and neoclassical two-sector growth model on variable like years of schooling as an investment rate. An important feature of the proposed specification is that it does not include additional variables such as work experience, which makes it easy to incorporate into existing

theoretical growth models and easy to adopt in growth accounting exercises. Husain [27] tests variables like Life Expectancy at birth (years) Infant Mortality Rate, Population with access to safe drinking water, Underweight children under five, Adult literacy Rate, Female literacy Rate, Gross enrolment ratio for all levels, Gross enrolment ratio for primary, Net primary enrolment ratio, Net Secondary enrolment ratio, Mean Years of schooling and Population growth rate. The study finds that the productivity benefits of education are large-just one additional year of education can increase productivity in wage employment by 10 percent even after controlling for other factors. Skill development through education has been identified as a key determinant of comparative advantage and manufacturing export performance. Also it is evidenced that districts with a higher literacy level have a higher level of development in Pakistan.

Babatunde and Adefabi [28] investigates in the case of Nigeria the relationship among gross domestic product (GDP), gross fixed capital formation, imports of goods and services, average years of schooling, primary, secondary and tertiary gross enrolments ratios, output per worker, labor force, general strikes, capital per worker and government expenditure on education by applying Johansen Co-integration technique and Vector Error Correction Methodology for the period of 1970-2003. The empirical findings of the study reveal that there is a long run relationship between education and economic growth. Also, trained and skilled labor force influence rate of economic growth significantly in both ways like as a factor in the production function and as a total factor productivity. Qureshi and Mohyuddin [29] scrutinize the variables like GDP, GDP growth, investment, investment as % GDP, health status, different type of diseases, where human capital is a determinant of growth by applying regression analysis for Pakistan. The study finds that health status indices are insignificantly linked with economic development. Additionally, among four diseases, two diseases are also insignificantly linked with economic development but the left two diseases like Malaria and Hepatitis are negatively and but significantly change the rate of economic development in the country. Finally, the study stresses that development polices should target the diseases of the working population.

Khan, Dijk and Heuvel [30] found that economic and socio-cultural context in the country significantly influence resource allocation for health policy and its implementation and therefore, it affects the health status of the people in Pakistan. Asiedu and Nandwa [31] empirically examine the effects on aid on growth by applying dynamic panel General Method of Moments (GMM) estimator for the period of 1990 - 2004 for 90 developing countries. The results show that the effect of aid varies by income as well as by the type of aid. Thus during the time when effects of aid on growth are analyzed, the results highlight the importance of the heterogeneity of aid flows as well as the heterogeneity of recipient countries.

Osipian [32] empirically testifies the relationship among real GDP growth per head (percent per annum), gross fixed investment (percent real *c*hange per annum), gross national savings rate (percent) and recorded unemployment (percent) by applying regression analysis for the time period of 1989 to 2010. The empirical results show that investments in fixed capital have positive effect on the GDP per capita growth rate. The results support that savings are not necessarily invested in the national economy at full scale. Also, the process of re-investment appears to be weak. Akram, Padda and Khan [33] investigate the factors affecting per capital GDP of Pakistan for the period of 1972-2006 by using Granger Causality Technique. The findings of the study depict that per capita GDP is positively influenced by health indicators in the long run but in the short run there does not exit significant relationship between health variables and economic growth. Hanushek and Wobmann [34] propagate that the cognitive skills of the population rather than mere school attainment are powerfully related to long-run economic growth. According to them the relationship between skills and growth proves extremely robust in empirical applications. The effect of skills is complementary to the quality of economic institutions. Schündeln and Playforth [35] apply Log Linear Specification for the period of 1961 to 2001in case of India. The study finds that there exits a significant public sector wage premium and during working for the public sector; it disproportionates the large numbers of highly educated people in India. It is also found that public sector enterprises are less productive when results are tested for firm level data and the average productivity gap between private and public sector enterprises increases with the size of the government sector in the state. Additionally, it is found in the state level data that the growth in educational capital in India shows positive impact on economic growth in states with small governments.

Kumba [36] explores the variables like consumption, health and education for Indonesia by applying direct method to calculate education Gini coefficient, average

years of schooling and standard deviations of education. The findings of the study reveal that economic growth strongly and significantly shows equalizing effect on the income distribution, which support the complementary relationship between equity and growth. Also investment in human capital contributes significantly to the growth of economy. Bukenya [37] exposes that there is a positive relation between fluctuations in health expenditure and economic growth. However, the empirical results of single variant and multivariate time series analysis suggest that only a weak relationship can be confirmed for the variables such as per capita GDP, Health Expenditure % of GDP, gross state product and time series.

Kalim and Shahbaz [38] investigate the relationship between economic growth and social development by applying ARDL Bound Testing technique of Co-integration for the period of 1971-2005 in case of Pakistan. The results reveal that there exists bivariate causal relationship between economic growth and social development. Nevertheless, the effect of social development on economic growth is much greater than the effect of economic growth on social development. Gong *et al*. [39] by using traditional Ramsey model under an exogenous growth framework empirically examine the relationship between health and consumption, which enable the study of health and growth in an aggregate macroeconomic model, the existence of multiple equilibrium of capital stock, health and consumption, which is more consistent with the real world situation - rich countries may end up with high capital, better health and higher consumption than poor countries, the fundamental proposition of a consumption tax instead of capital taxation. Huang, Fulginiti and Peterson [40] worked on the supposition that an increased probability of premature death reduces investment in human capital and consequently slower growth. The study shows empirically that HIV/AIDS has declined life expectancy substantially in African countries. The fall in life expectancies is because of worldwide illiteracy and slow pace of economic growth.

Qadri and Waheed [41] empirically tested the relationship between human capital and economic growth for Pakistan by using Cobb-Douglas production function for the period of 1978 to 2007. The results reveal that human capital and economic growth are positively related to each other. The health adjusted education indicator was found to be a highly significant determinant of economic growth, which indicates that both the health and education sectors should be give special attention in order to ensure long run economic growth.

The past researches validate the existence of positive relationship among the variables like health; economic growth and education in case of other developing countries. No study yet has been carried out in case of Pakistan in finding out the triangular relationship between health, education and economic growth. On the basis of the literature review it is hypothesized that there exists a positive relationship among economic growth, per capita education expenditures and per capita health expenditures in case of Pakistan.

Data Source and Methodological Framework:

Data Source: The data[3] for Per capita real GDP is obtained from world development indicators World Bank [42] up to 2007 and remaining values for the next two years are taken from Federal Bureau of Statistics [43], Islamabad, Pakistan. The data for Per capita education expenditures is obtained from the various volumes and issues of Pakistan Economic Survey [44] and the data for Per capita health expenditures is taken from FBS [43]. However; the empirical findings of the present study deal with the data ranges from 1972 up to 2009.

Methodological Framework: To avoid inconsistent and insignificant results computed through linear form approach; the present study applies the log linear form of the model. Log linear form is fruitful to organize the magnitude of the data and it also examines significant, consistent and reliable results. Bowers and Pierce [45] investigate that the results are sensitive if they are calculated via functional form method. Further, Ehrlich [46] and Layson [47] shed light on the hypothetical and speculative grounds that investigational conclusions acquire by applying the way of linear form, are not well-organized to fight with the estimated results obtained from log linear models. Additionally; Cameron [48] and Ehrlich [49] reveal the importance and extent of the log linear models and conclude that if it is desired to achieve significant, consistent and reliable results, then always apply log linear models on the data set as compared with linear models. This leads to construct log-linear model as given below:

[3]The data on all the variables is available on the special request from the authors

$$Lgt = \alpha_C + \alpha_{Et} Let + \alpha_{Ht} + \varepsilon_1 \quad (3.1)$$

$$Let = \beta_C + \beta_{Gt} LGt + \beta_{Ht} Lht + \varepsilon_2 \quad (3.2)$$

$$Lht = \gamma_C + \gamma_{Et} LEt + \gamma_{Gt} LGt + \varepsilon_{t3} \quad (3.3)$$

Where,

Gt = Real GDP per capita
Et = Per capita Education Expenditures
Ht = Per capita Health Expenditures

Estimation Technique: The stationarity of the data in the present study is estimated by applying Ng-Perron test; once it is confirmed that the data becomes stable, then, the next step is to find out Lag Length for investigating the long run association among Per capita real GDP, Per capita education expenditures and Per capita health expenditures. ARDL bounds testing method is more appropriate to examine long run relationship among the variables if number of observations are less than 50 and above than 30. Also, the data is stationary at I(0), I(1), I(2), or mixed. The following are the steps of computing data:

Computing Stationarity: The stationarity of the data is computed by applying Ng - Perron test. This test is theoretically developed by Joseph and Sinha [50]. This test is superior over the conventional techniques such as Augmented Dickey-Fuller (ADF), Phillips and Perron (P-P) of investigating stionarity. This test is more appropriate for the data set which contains limited number of observations (like less than 50 and above than 30) and this test elaborates the computed results in a strong manner as compared to traditional unit root tests. There are four tests in the Ng-Perron unit root approach such as Phillips - Perron [51]; *Za and Zt*, Bhargava [52] R1 and ERS test for optimal point. All the above mentioned tests depend on GLS de - trend data $\Delta y\, t$.

$$k = \sum_{t-2}^{T} (yd_{t-1})2/T2$$

Estimating Cointegration: The cointegration is examined among the operating variables of the present study by applying ARDL bound testing approach. The ARDL bound testing approach was initially introduced by Pesaran *et al*. [53]. Also the error correction model (ECM) is found by processing ARDL model through simple linear transformation presented by Banerrjee and Newman [54]. ARDL bounds testing method is more appropriate to examine long run relationship among the variables if number of observations are less than 50 and above than 30. Also, ARDL bounds testing method is appropriate to apply if the data becomes stationary at I(0) or I(1) or I(2) or at mixed order.

Pesaran *et al*. [53] confirm the existence of long run relationship among the variables if the calculated value of F - statistic is greater than the upper critical bound (UCB); and there does not exist long run relationship among the operating variables udy if the calculated value of F - statistic is less than the lower critical bound (LCB) and finally if calculated value of F - statistic comes in between the range of LCB and UCB then conclusion about long run association becomes inconclusive. Additionally, various diagnostic checks are also applied to validate the best fitness of the ARDL model. Equations (3.4 to 3.6) investigate the existence of long run relationship among the variables of the present study.

$$\Delta LG_t = \alpha_1 + \alpha_2 LG_{t-1} + \alpha_3 LE_{t-1} + \alpha_4 LH_{t-1} + \omega_{G_t} \sum_{i=1}^{p} \Delta LG_{t-i} + \omega_{E_t} \sum_{i=0}^{p} \Delta LE_{t-i} + \omega_{H_t} \sum_{i=0}^{p} \Delta LH_{t-i} + \mu_{t1} \quad (3.4)$$

$$\Delta LE_t = \beta_1 + \beta_2 LG_{t-1} + \beta_3 LE_{t-1} + \beta_4 LE_{t-1} + \delta_{E_t} \sum_{i=1}^{p} \Delta LE_{t-i} + \delta_{G_t} \sum_{i=0}^{p} \Delta LG_{t-i} + \delta_{H_t} \sum_{i=0}^{p} \Delta LH_{t-i} + \mu_{t2} \quad (3.5)$$

$$\Delta LH_t = \gamma_1 + \gamma_2 LG_{t-1} + \gamma_3 LE_{t-1} + \gamma_4 LH_{t-1} + \psi_{H_t} \sum_{i=1}^{p} \Delta LH_{t-i} + \psi_{E_t} \sum_{i=0}^{p} \Delta LE_{t-i} + \psi_{G_t} \sum_{i=0}^{p} \Delta LG_{t-i} + \mu_{t3} \quad (3.6)$$

Engle-Granger [55] opine that cointegration shows insignificant and inconsistent results when at first difference vector auto regression (VAR) test in Granger Causality is conducted. These inconsistent and insignificant results are corrected by modifying the equations of ARDL in such a way that the term of error correction is added into the equations of ARDL. This term of error correction should be significant with negative sign to reveal existence and direction of long run relationship. Additionally, if results are significant at 1st difference then it reveals direction of short run. The vector error-correction model (VECM) which has bivariate *p*th order is given as below:

$$\Delta LG_t = \alpha_{11} + \alpha_{22}\sum_{i=1}^{p}\Delta LG_{t-i} + \alpha_{33}\sum_{i=0}^{p}\Delta LE_{t-i} + \alpha_{44}\sum_{i=0}^{p}\Delta LH_{t-i} + \lambda_1 ECM_{t-1} + \eta_{1t} \quad (3.7)$$

$$\Delta LE_t = \beta_{11} + \beta_{22}\sum_{i=0}^{p}\Delta LG_{t-i} + \beta_{33}\sum_{i=1}^{p}\Delta LE_{t-i} + \beta_{44}\sum_{i=0}^{p}\Delta LH_{t-i} + \lambda_2 ECM_{t-1} + \eta_{2t} \quad (3.8)$$

$$\Delta LH_t = \gamma_{11} + \gamma_{22}\sum_{i=0}^{p}\Delta LG_{t-i} + \gamma_{33}\sum_{i=0}^{p}\Delta LE_{t-i} + \gamma_{44}\sum_{i=1}^{p}\Delta LH_{t-i} + \lambda_3 ECM_{t-1} + \eta_{3i} \quad (3.9)$$

Variables and Hypothesis: The following is the brief explanation of the variables taken in the model.

Per Capita Real GDP: Per capita real GDP is obtained by dividing total real GDP on total population for each year from 1972 - 2009. Real GDP per capita is important because it ensures opportunities to the investors to expand volume of investments in the country. This boots up the employment opportunities and living standard of the people. Therefore, more funds available to the people will ultimately reveal their attention to focus on both health and educational facilities in the country. Therefore, volume of human capital expands in the country like Pakistan.

Per Capita Education Expenditures: Per capita education expenditures are obtained by dividing the total education expenditures on total population for each year from 1972 - 2009. Per capita expenditures on education is taken as the source of human capital. It is hypothesized that if government of Pakistan increases its volume of development expenditures on education; the working class will become well equipped and sound in terms of latest techniques of production and research and development. This will enhance their productivity skills which ultimately benefit the manufacturing class. The returns to business class will encourage more investments in the country leading to enhance rate of economic growth in the country like Pakistan.

Per Capita Health Expenditures: Per person health expenditures are achieved by dividing the total health expenditures on total population for each year from 1972 - 2009. Per capita expenditures on health are also considered as another source of human capital. It is assumed that if government of state raises its expenditures on health; people of Pakistan enjoy health life and death rate declines from the country. This will not only enhances the volume of labor force in the country but also uplifts the productivity of the inputs like labor. The reason is that a sound body has a sound mind. Therefore, when working class feels health then they will be able to perform efficiently on their jobs. Hence, they will positively contribute to the rate of economic growth.

Empirical Estimation[4] and Interpretation of the Results: Table 4.1 represents the descriptive statistics and pair-wise correlations. Per capita education expenditures and per capita health expenditures are positively linked with real GDP per capita. Also per capita education expenditures and per capita health expenditures are positively linked with one another. The values of mean and median are in between the range of minimum and maximum values. Therefore, the above table concludes that the distribution is normal. The next step is to test stationarity of the data. The literature exposes that order of integration of the variables is tested by the various conventional techniques like ADF [56, 57], P-P [51] and DF-GLS [58]. However, these techniques are used to investigate the stationarity of the model which appear to over-reject the H_0 at the time when it becomes accurate and vice versa otherwise. Ng-Perron [59] unit root test is more suitable to deal with such problems. This method is well-built, strong and consistent for the data set in which number of observations are limited if it is compared to other long-established unit root tests.

Table 4.2 depicts the results computed by Ng-Perron test. The results of Table 4. 2 shows that real GDP per capita (Gt), per capita education expenditures (Et) and per capita health expenditures (Ht) are not stationary at level, therefore, these variables are tested at first difference and it is evidenced that all these variables have become stationary at 1% and 5% levels of significance respectively. Since number of observations are less than

[4]The authors are highly thankful to Ms. Saima Zulfiqar and Mr. Usman Bashir Hafiz who are the students of BBA (H), Department of Economics, School of Business and Economics, University of Management and Technology, Lahore, Pakistan, for their assistance in data compilation

Table 4.1: Descriptive Statistics and Correlations

Variables	InG_t	InE_t	InH^t
Mean	0.0239	0.1746	0.1101
Median	0.0229	0.1247	0.0844
Maximum	0.0681	1.0006	0.9004
Minimum	-0.0139	-0.3189	-0.2840
Std. Dev.	0.0193	0.2352	0.1907
Skewness	0.0700	1.3237	1.9982
Kurtosis	2.3331	5.9678	9.5759
InG_t	1.0000		
InE_t	0.2901	1.0000	
InH_t	0.1661	0.6882	1.000000

Table 4.2: Ng - Perron Unit Root Test:

	Ng-Perron at level with Intercept and Trend $I(_0)$			
Variables	MZa	MZt	MSB	MPT
InG_t	-4.0781	-1.3779	0.3378	21.7784
InE_t	-1.6213	-0.7919	0.4884	46.6828
InH_t	-1.8610	-0.7881	0.4234	37.3790
	Ng- Perron at 1st Difference with Intercept and Trend $I(_1)$			
ΔInG_t	-26.8989*	-3.6668	0.1363	3.3906
ΔInE_t	-19.3452**	-3.1020	0.1603	4.7589
ΔInH_t	-24.2268*	-3.4804	0.1436	3.7614

Note: *&** indicate significance at1% & 5% level

Table 4.3: Lag Order Selection Criteria

VAR Lag Order Selection Criteria			
Lag	LogL	LR	F P E
	AIC	SC	HQ
0	11.8643	NA	0.000121
	-0.5065	-0.3732	-0.4605
1	138.1221	223.6566	1.49e-07
	-7.2069	-6.6737*	-7.0228
2	153.2365	24.1830*	1.07e-07*
	-7.5563*	-6.6231	-7.2342*
3	156.6969	4.94340	1.51e-07
	-7.2398	-5.9066	-6.7796

* 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-Quinn Information Criterion

50 and more than 30; and variables are not stationary at level, therefore, to investigate the association among real GDP per capita (Gt), per capita education expenditures (Et) and per capita health expenditures (Ht) in the long run period of time, ARDL bounds testing approach to co-integration is applied.

Table 4.2 reveal the results computed by Ng - Perron test.

The literature suggests that the tests for computing long run association among the variables can not be applied before selecting an appropriate lag order of the variables. The present study shows the lag - length of the variables as 2, which is selected by Akaike Information Criteria (AIC) and the results are expressed in Table 4.3.

Table 4.3 examine the lag order of the variables by applying different tests and among all; the value computed by AIC is the minimum, so, the lag - order of the variables 2 is selected by using AIC critera. Now the next step is to apply ARDL bounds testing approach to investigate the long run strength of relationship among real GDP per capita (Gt), per capita education expenditures (Et) and per capita health expenditures (Ht). Table 4.4 shows the estimated results for existence of co-integration and for goodness of fit by using ARDL - model.

Table 4.4 confirms the existence of long run association among the operating variables in the present study. F - Statistics is computed for this reason and the calculated value of F - statistic in the model no. 1 is greater than the upper critical bound such as (7.7878** > 6.437) at 5% level of significance and hence showing that there exists long run association among the variables of model no. 1 which is $G_t = f(E_t, H_t)$. Now, the calculated value of F- statistic for the model no. 2 is greater than the upper critical bound such as (9.7829* > 8.803) at 1% level of significance and hence showing that there exists long run association among the variables of model no. 2 which is $E_t = f(G_t, H_t)$. Similarly, the value of F - statistics is calculated for the model no. 3 and it is again greater than the upper critical bound such as (8.6696** > 6.437) at 5% level of significance and hence showing that there exists long run association among the variables of model no. 3 which is $H_t = f(G_t, E_t)$. Therefore, it is concluded on the basis of above table that there exists three cointegrating vectors in the present study for the period of 1972 - 2009 hence confirming that there exists long run association among real GDP per capita (Gt), per capita education expenditures (Et) and per capita health expenditures (Ht) in Pakistan for the period of 1972 - 2009. Table 4.4 also discloses the computed values for the diagnostic checks along with the probability values such as R^2, Adjusted R^2, F - statistic, J - B Normality test, Breusch - Goldfrey LM test, ARCH LM test, Heteroskedasticity test and Ramsey RESET test. All the diagnostic checks for all the three models reject the null hypothesis that model is not best fit against the alternative hypothesis of model is best fit. Once it is confirmed that the ARDL Bounds testing

Table 4.3: Lag Order Selection Criteria

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	11.8643	NA	0.000121	-0.5065	-0.3732	-0.4605
1	138.1221	223.6566	1.49e-07	-7.2069	-6.6737*	-7.0228
2	153.2365	24.1830*	1.07e-07*	-7.5563*	-6.6231	-7.2342*
3	156.6969	4.94340	1.51e-07	-7.2398	-5.9066	-6.7796

* 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-Quinn Information Criterion

Table 4.4: ARDL Bounds Testing Approach to Co-integration

Estimated Models	$G_t = f(E_t, H_t)$	$E_t = f(G_t, H_t)$	$H_t = f(G_t, E_t)$
Optimal lags	(2, 1, 1)	(2, 1, 1)	(2, 2, 1)
F-statistics	7.7878**	9.7829*	8.6696**
Significant level	Lower Critical Bound	Upper Critical Bound	
1 per cent	7.527	8.803	
5 per cent	5.387	6.437	
10 per cent	4.477	5.42	
Diagnostic Tests			
R^2	0.52	0.9171	0.833
Adjusted - R^2	0.28	0.8757	0.7376
F-statistics	2.1670*	22.1468***	8.7305***
J-B Normality test	0.5178 (0.7718)	0.6879 (0.7089)	0.9896 (0.6096)
Breusch-Godfrey LM Test	1.7450 (0.2002)	0.2319 (0.6350)	1.2502 (0.3089)
ARCH LM test	0.8079 (0.3757)	0.5583 (0.4606)	0.3321 (0.5685)
Heteroskedasticity Test	1.1858 (0.3510)	0.7638 (0.6704)	0.8042 (0.6435)
Ramsey RESET	1.6422 (0.2140)	1.7030 (0.2075)	1.7632 (0.1902)

Note: *, **&*** show significant at 1%. 5% & 10% level respectively. We have used critical bounds developed by Narayan (2005)

Table 4.5: The results of Granger causality

	Type of Granger causality						
	Short-run			Long-run	Joint (short- and long-run)		
Dependent variable	$\Delta \ln G_t$	$\Delta \ln E_t$	$\Delta \ln H_t$	ECM_{t-1}	$\Delta \ln G_t$, ECM_{t-1}	$\Delta \ln E_t$, ECM_{t-1}	$\Delta \ln H_t$, ECM_{t-1}
	F-statistics [p-values]			[t-statistics]	F-statistics [p-values]		
$\Delta \ln G_t$	-	2.7972*[0.0777]	0.4341[0.6519]	-0.2038**[-2.4251]	-	3.5549**[0.0264]	2.4460*[0.0839]
$\Delta \ln E_t$	4.2253**[0.0254]	-	27.8858***[0.0000]	-.2661***[-3.3843]	5.2013***[0.0054]	-	20.2830***[0.0000]
$\Delta \ln H_t$	1.5013[0.2396]	16.1378***[0.0000]	-	-0.6062***[-4.1339]	5.7739***[0.0032]	17.6070***[0.0000]	-

Note: The asterisks ***, ** and * denote the significant at the 1%, 5% and 10% levels, respectively

approach is best fit in the present study; now, the time is to move forward to test the unidirectional or bidirectional causality among the running actors of the present study for Pakistan for both short run and long run periods of time over the time span of 1972-2009.

The VECM and Direction of Causality among Economic Growth, Education and Health: The Granger Causality test is significant to examine and estimate direction of causality among the operating variables such as growth per capita, education expenditures per capita and health expenditures per capita in the presence of cointegration both in short run and long run periods of time. The researchers reveal that VECM technique is more suitable to investigate the direction of causality among the variables for both short run and long run time periods. The underneath table exposes the picture clearly.

The Granger Causality table (Table 4.5) depicts three segments; the first segment reveals the causal relation between dependant and independent variables in the short run, the second segment shows the causal relation between the dependant and independent variables in the long run and these results are shown by using the values of ECM_{t-1}. The third and final segment investigates the

joint causal relationship between dependant and independent variables for both short run and long run periods of time. Since the economic growth, education and health are co-integrated with another; therefore, the long run causality is estimated by the negative signed and significant value of the coefficient of the one period lagged error-correction term *ECM t* - 1 by applying t-statistics. The results for the short run causality among the variables could also be found by the combined significance of LR - test of the lagged independent variables in the equation. The results for short run granger causality for model no. 1 $G_t = f(E_t, H_t)$ expose that education does granger cause economic growth in the short run at 10% percent level of significance. Additionally, the result of health expenditures per capita reveals that health expenditures per capita do not granger cause economic growth in the short run which means present expenditures on health will elevate efficiency of the inputs like human capital in the long run hence expanding their productivities and rate of per capita economic growth. Hence, indicating that there exists unidirectional relationship between economic growth per capita and education expenditures per capita in the short run period of time. The estimated result for long run period of time in the table above reveal that the coefficient of the one period lagged error-correction term *ECM t* - 1 (-0.2038**, t = -2.4251) for model no. 1 $G_t = f(E_t, H_t)$ depicts negative and significant value at 5% level of significance. It shows that there persists bidirectional granger causality in model no. 1, that means per capita education expenditures and per capita health expenditures do cause per capita real GDP and vice verse in the long for the period of 1972 - 2009. In addition to it, the joint causality test for both short run and long run periods of time is conducted for model no. 1 $G_t = f(E_t, H_t)$ and the above table exposes the results for the model no. 1 that there exists joint causality for model no. 1 for both short run and long run periods of time for the period of 1972-2009.

The estimated results for short run granger causality for model no. 2 $E_t = f(G_t, H_t)$ disclose that per capita real GDP does granger cause per capita education expenditures in the short run at 5% percent level of significance. Additionally, the result of health expenditures per capita reveals that health expenditures per capita also granger causes per capita education expenditures in the short run at 1% level of significance.

The computed result for long run period of time in the table above depict that the coefficient of the one period lagged error-correction term *ECM t* - 1 (-0.2661***, t = -3.3843) for model no. 2 $E_t = f(G_t, H_t)$ exposes negative and significant value at 1% level of significance. It shows that there persists bidirectional causality in model no. 2, that means per capita real GDP and per capita health expenditures do granger cause per capita education expenditures and vice versa in the long for the period of 1972 - 2009. Besides it, the joint causality test for both short run and long run periods of time is conducted for model no. 2 $E_t = f(G_t, H_t)$ and the above table discloses the results for the model no. 2 that there exists joint causality for model no. 2 for both short run and long run periods of time for the period of 1972-2009.

The computed results for short run causality for model no. 3 H_t - $f(G_t, E_t)$ unveil that per capita real GDP does not granger cause per capita health expenditures in the short run. Additionally, the result of education expenditures per capita shows that education expenditures per capita does granger cause per capita health expenditures in the short run at 1% level of significance. The estimated result for long run period of time in the table above demonstrate that the coefficient of the one period lagged error-correction term *ECM t* - 1 (-0.6062***, t = -4.1339) for model no. 3 $H_t = f(G_t, E_t)$ examines negative and significant value at 1% level of significance. It shows that there persists bidirectional granger causality in model no. 3, that means per capita real GDP and per capita education expenditures do granger cause per capita health expenditures and vice versa in the long for the period of 1972 - 2009. Moreover, the joint causality test for both short run and long run periods of time is conducted for model no. 3 $H_t = f(G, E)$ and the above table discloses the results for the model no. 3 that there exists joint granger causality for model no. 3 for both short run and long run periods of time for the period of 1972-2009.

CONCLUSION

Conclusions and Policy Implications: The core rationale of the study is to investigate the existence of long run relationship and triangular causality among real GDP per capita, per capita education expenditures and per capita health expenditures in Pakistan for the time series data from 1972-2009. The objective of finding long run relationship among the operating variables is achieved by applying ARDL bounds testing approach and this technique validates that there exists long run relationship among running actors of the economy in Pakistan. The objective of estimating triangular causality among these variables is fulfilled by applying Granger Causality and

VECM. The results disclose that real GDP per capita granger causes per capita education expenditures and per capita education expenditures also granger cause real GDP per capita; hence, confirming that there exists bidirectional granger causality between per capita real GDP and per capita education expenditures in the short run period of time in Pakistan. The empirical evidence is consistent with Abbas [21] and Babatunde and Adefabi [28]. Per capita health expenditures does not granger cause real GDP per capita and real GDP per capita also do not granger cause per capita health expenditures in Pakistan in the short run; hence, there does not exist granger causality between per capita health expenditures and per capita real GDP in short run in Pakistan. The results are consistent with Rivera and Currais [20]; Akram, Padda and Khan [33], Bukenya [37] and Qadri and Waheed [41]. In the long run period of time there exits bidirectional causality among real GDP per capita, per capita education expenditures and per capita health expenditures. Additionally, the present study also validates the existence of the joint causality among the operating variables in Pakistan in both short run and long run periods of time.

Policy Implications: The researchers confirm that human capita based on education and health performs a vital role in uplifting the pace of economic growth; therefore, the efforts should be made by the government of Pakistan in its budget to enhance the development expenditures on education and health. This will provide a healthy life and better awareness to the people of Pakistan that ultimately improves quality of life and efficiency of the inputs by which more trained and health inputs are available to industry and all the manufacturing units in the country like Pakistan. This will bring economies of scale in the country leading to reduce cost of production and increase returns to manufacturers. This will not only speed up the process of industrialization but also improves the pace of economic growth in the country like Pakistan. In addition to it, electronic media must come forward to start some awareness programs in the fields of education and health that will at least provide basic information to the people of Pakistan who will use this basic information on their jobs to keep them more productive and updated about the new techniques of production which ultimately benefit to the manufacturing units that finally improves rate of economic growth in Pakistan. Moreover, such an environment should be designed in the country that promotes volumes of foreign investment in addition to domestic investment in the health and education sectors of Pakistan. This will remove state of unemployment from the country on the one side and also achieve the target of high growth rate by improving both education and health sectors in Pakistan.

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