

## **Relationship among Education, Poverty and Economic Growth in Pakistan: An Econometric Analysis**

**Muhammad Afzal\***  
**Muhammad Ehsan Malik\*\***  
**Ishrat Begum\*\*\***  
**Kafeel Sarwar\*\*\*\***  
**Hina Fatima\*\*\*\***

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### **Abstract**

Nations cannot be developed without investing in education. Education is a multidimensional process, on one side, it enhances the economic growth and on the other side, it reduces the poverty by increasing the productivity. Poverty has strong linkages with education and economic growth. This study utilizes time series data on education, poverty, physical capital and economic growth for the span of 1971-72 to 2009-10 in case of Pakistan. The results of ARDL model confirm that both the short-run and long-run affect of physical capital on economic growth have been found to be positive and significant. Education affects economic growth positively and significantly only in the long-run. In the long-run, poverty and economic growth are inversely and significantly related. The results of Toda-Yamamoto Augmented Granger Causality (TYAGC) Test confirm bi-directional causality between education and economic growth, between economic growth and poverty and between poverty and education. Poverty reduction and education enhancing strategies must be adopted to accelerate the process of economic growth of the country. The study also recommends pro-poor growth and education in Pakistan.

**Keywords:** Education, Poverty, Economic Growth, ARDL, Causality.

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\* Lecturer, Department of Economics, University of the Punjab, Lahore

E-mail: muhammad\_afzalch@yahoo.com

\*\* Professor & Director, Institute of Business Administration, University of the Punjab, Lahore

E-mail: drmalikehsan@hotmail.com

\*\*\* Assistant Professor of Political Science, Government College for Woman, Gulberg, Lahore

E-mail: ask4ishratbegum@gmail.com

\*\*\*\*M.Phil Student, Department of Economics, University of the Punjab, Lahore

E-mail: kafeelsarwar80@gmail.com, E-mail: hinafatima02@gmail.com

## Introduction

The term human capital was firstly used in 1960's and 70's, when Mincer (1958), Goode (1959), Schultz (1961) and Becker (1975) gave the different point of view regarding the concept and formation of human capital. However, human capital accumulation got importance by the emergence of endogenous growth theory given by Lucas (1988) and Romer (1989, 1990). Mankiw *et al.* (1992) firstly used human capital in production function. It is expected that higher level of human capital leads to higher rate of economic growth. There are many ingredient of human capital *i.e.* education, health, on job trainings, skills, aptitudes and migration to better job, but education serves as the most important ingredients of human capital (Goode, 1959; Schultz, 1961; Khilji 2005).

Nations cannot be properly developed without education. Raja (2000) argued that education is the first step in the path of development process. It is a two way process, on one side, it increases the economic growth and on the other side, it reduces the poverty and increases the productivity. It plays a very crucial role in building of human capabilities and enhances economic growth through skills and knowledge. Investors are more interested in that country, where there is ample stock of human capital.

Education is the imperative part of human competency and sovereignty (Sen, 1999). Kim & Terada-Hagiwara (2010) elaborated the importance of well-educated labor force as it is considered necessary in the diffusion and adoption of new technology and new methods of production. It plays a crucial role in developing countries like Pakistan, as; they have shortages of physical and human capital. The quantity as well as the quality of education at each level with its linkages to demand for skills is very critical for economic growth (HDR, 2001; Adawo, 2011).

Educational institutions, investments in education, quality of education and equal access to education play the imperative role in the alleviation of poverty and enhancing economic growth (Chaudhry & Rehman, 2009; Santos, 2009; Moaz & Neeman, 2008). Burneth *et al.* (1995) and Ijaiya (1998) said that investment in education increased GNP per capita, reduced poverty and supported the spreading out in knowledge. Education is also playing a significant role in the reducing income inequalities (Dănăcică, Belascu & Llie, 2010). It also helps to lower the crime rate, terrorism and child labor through reducing the poverty. People commit these crimes as they are not capable to fulfill the basic needs of life. (Kruger & Malečková, 2003; Fabre & Augersaud-Veron, 2004).

Education has economic objectives along with many other objectives. As, Babatunde & Adefabi (2005) argued that education is triggering economic growth through many factors like enhancing the employment opportunities, improving health facilities, reducing fertility and poverty level, improving technological development and source of political stability. In Pakistan, education in private as well as in public sector faces a number of problems. This sector has always been neglected in Pakistan. Lower investment in education, high level of inflation and poverty, income inequalities, gender inequalities, regional inequalities, poor condition of public sector educational institutions, high fee in private sector educational institutions, having various systems of education, societal environment, poor educational policies and poor implementation were the main causes behind this negligence. These have been the big hurdles in the way of educational development and human capital accumulation in Pakistan.

Education is strongly linked with poverty as parents seems to be reluctant to send their children for education due to poverty. Moroto (2000) argued that the linkage between education and economic growth is not always direct. There are also other economic and non-economic variables that affect the linkages between education and economic growth. Studying the relationship among education, poverty and economic growth in Pakistan with the inclusion of other macroeconomic variables like physical capital seems to be very important. Physical capital is included in the study because it is considered to be the basic ingredient of economic growth theory. Physical capital formation also affects both of the education and the poverty. Education serves as one of the most important ingredients of human capital as well as of the economic growth. On one side, education is always neglected by higher authorities and on the other side, poverty is also increasing with the passage of time and Pakistan has failed to sustain her economic growth. So, the present study explores the short run (SR) and long run (LR) relationship among education, poverty, physical capital and economic growth in Pakistan by utilizing ARDL approach to cointegration. Causal nexus among education, poverty, physical capital and economic growth in case of Pakistan is also tested by utilizing Toda-Yamamoto Augmented Granger Causality framework. This study also explore whether there exist unidirectional or bidirectional causality between education and economic growth, between poverty and economic growth, and between education and poverty in case of Pakistan.

### ***Objectives of the Study***

The present study is based on the following objectives:

- a. To assess the effect of education, physical capital and poverty on economic growth in case of Pakistan's economy.
- b. To examine the short-run (SR) and long-run (LR) linkages between education, poverty, physical capital and economic growth in case of Pakistan's economy.
- c. To determine the causal nexus among education, physical capital, poverty and economic growth in Pakistan.

### ***Delimitation of the Study***

The relationship between education and economic growth is affected by many factors like stock of capital, labour, poverty, inflation, terrorism, debt accumulation, population, foreign aid, political instability, rule of law, international openness, fertility rate, investment to GDP ratio and last but not least the institutional and sociological factors. But due to limited time and data, the present study confines only to examine the relationship between education, poverty, physical capital and economic growth in case of Pakistan.

### ***Literature Review***

The education is the first step in the way of development process and it provides the basis for the improvement of the socio-economic condition of a country. Many studies are presented at national and international level concerning education and growth linkages. Literature review of some related studies is presented below.

Generally, education is considered as an important instrument to reduce poverty. Fabre & Augersaud-Veron (2004) estimated the effect of poverty and educational policies on child labour, growth and school attendance. They have found that there is tradeoff between human capital accumulation and child labour. Poor people are not capable of sending their children to private educational institutions to attain high quality of education. Although, public education system generates and widens poverty gap, as this system provide low quality education which deteriorate the economic growth. They also argued that poverty gap could be widened in absence of quality education which has become the source of child labor. The public policies are required to break the poverty gap by focusing on the quality education which, in turn, leads to economic growth. High literacy rate was not the guarantee of peace, justice and prosperity in a society (Raja, 2010). It is observed in many countries of

the world that even in presence of high literacy rate, they remained underdeveloped. Country only becomes the developed country when it attains the high literacy rate.

Danacica, Belascu & Llie (2010) used time series data for the span of 1980-2008 to explore the causal nexus between higher education and economic growth in case of Romania. The results of their study have confirmed that there is LR relationship between higher education and economic growth and one way causality *i.e.* running from economic growth to higher education has been observed. However this study faces serious drawback as in this study, Johansen & Juelius (1990, 1995) technique on 28 observations has been used with four optimal lag lengths. Due to small sample, this technique may mislead the results and also may loss of the degree of freedom. Kruger & Maleckova (2003) studied the causal relationship between education, poverty and terrorism. They explored that poverty, low wages, low level of education and Madarasa's education has become the causes of committing crime. Emadzadeh *et al.* (2000), Nili & Nafisi (2003), Mohamadi (2006), and Komijani & Memernejad (2004) analyzed the effect of education on economic growth in case of Iran and found that education had a positive and significant effect on economic growth of Iran.

Human capital can be developed through savings and then making investment in health and education sectors (Moav & Neeman, 2008). They have found that human capital and poverty are inversely related. Whereas, less educated people are less concerned about their status so they consume more than their savings and hence they remain in the poverty trap. Hakim, Razak & Ismail (2010) examined the causal relationship of social capital and poverty in Malaysia. The estimated results of Logit model showed that social capital played a significant role in the poverty reduction. Along with social capital, human capital, physical capital, age and gender of the head of household, size of household also play significant role in poverty alleviation. With the development of economic institution and human capital, poverty could be diminished. Norton (2010) estimated OLS model and showed that property rights and economic freedom increases the magnitude of schooling. This revealed that, institutions help to reduce poverty by strengthening the human capital.

In Pakistan, agriculture sector employed more than 45% of population. Out of which, 85% are the small farmers. Sabir, Hussain & Saboor (2006) have used the sample of 300 small farmers of central Punjab to investigate the status of poverty among them. They found that education is the factor that could reduce poverty. However, old age of the head of household, large size of household, small output and low price, insufficiency of infrastructure and dependency ratio are the few determinants of high poverty in central Punjab, Pakistan. Gender inequality in access

of education facilities could enhance poverty level and hinders the economic growth. By using Logit regression model, Chaudhry & Rehman (2009) have estimated that, in Pakistan, the size of household and female to male ratio has significant and positively impact on poverty. While female to male enrollment ratio, literacy ratio of female to male, education of head of household and ratio of earners of female to male have been significantly and negatively affected the rural poverty. They suggest that education and employment opportunities should be equalized which could hinder poverty and resultantly enhances the economic growth. Chaudhry (2007) examined the impact of gender inequality in education on economic growth in Pakistan using time series approach. The result of the study has showed that gender inequality had a significant and positive impact on economic growth. Whereas, literacy rate, enrollment ratio, literate female to male ratio has direct and significant effect on economic growth.

Ali & Nishat (2010) have observed the effect of foreign inflows on poverty through education, health and other human development indicators. They used ARDL approach to cointegration on time series data for the period of 1972 to 2008 in case of Pakistan. They found positive relationship between poverty, infant mortality, female enrollment and foreign inflows. Awan *et. al.* (2008) explored the determinants of poverty in Pakistan using Household Integrated Survey of 1998-99 and 2001-02. For this purpose, they used different levels of education, gender of employed person and experience as the determinants of poverty. They concluded that educational achievement and experience were inversely related to poverty. By using time series data from 1972 to 2007, Chaudhry *et. al.* (2010) explored the role of education in reducing the poverty in Pakistan. The results of their study confirm that primary and middle education is positively and insignificantly related to poverty. University education is negatively and significantly related to poverty. They also found that growth and poverty were negatively but insignificant related. Chaudhary, Iqbal & Gillani (2009) used time series data to investigate the causality between higher education and economic growth in Pakistan. They applied Johansen co-integration approaches in a Vector Auto Regressive framework and Toda-Yamamoto (1995) causality technique in their analysis for the period of 1972 to 2005. The results of cointegration approach confirm the LR relationship between education, labour, capital and RGDP (real gross domestic product). Causality results confirm the unidirectional causality from RGDP to higher education. Afzal *et al.* (2010) analyzed the SR and LR relationship between school education and economic growth in case of Pakistan by using ARDL approach to cointegration. Their study used annual time series data on real GDP, physical capital in real terms, poverty, inflation and general school enrollment ratio for the period of 1970-71 to 2008-09. The results of the study

by Afzal *et al.* (2010) confirm the cointegration among real GDP, poverty, inflation and school enrollment ratio when both the real GDP and school enrollment ratio serves as the dependent variables. The results of their study also confirmed that in SR, school education and economic growth were inversely related, while in the LR, two way direct relationships found between school education and economic growth. Policy actions aiming at increasing school education, eliminating poverty and accelerating economic growth were recommended in their study. Afzal, Rehman, Farooq and Sarwar (2011) examined the cointegration and causality between education and economic growth in case of Pakistan by using time series data for the period of 1971-1972 to 2008-2009. Their study has used ten different indicators to measure education. The results of their study confirm the log run relationship between education, labour force, physical capital and economic growth in case of Pakistan. The results of causality confirmed bi-directional causality between education and economic growth. Their study recommends more investment in university education that, in turn, leads to more economic growth in Pakistan.

The present research work is different from almost all of above studies in the sense that it analyses the linkage among education, poverty and economic growth with the inclusion of physical capital as one of the most important macroeconomic variables. This study also applies the latest and more suitable econometric techniques *i.e.*, Auto-Regressive Distributed Lag Approach (ARDL) and Toda-Yamamoto Augmented Granger Causality (TYAGC) Approach to check the robustness of the results. Furthermore, there is hardly any study in Pakistan that explores the linkage between education and economic growth in the presence of two other very important macroeconomic variables such as poverty and physical capital. The present study is a significant addition in existing literature in the sense that it explores the comprehensive relationship among education, poverty and economic growth in the presence of physical capital in case of Pakistan.

### ***Data Sources and Methodology***

The present research has used time series data on education, real gross domestic product, poverty, and physical capital for the time span of 1971-72 to 2009-10 in case of Pakistan. Data were collected from various issues of Pakistan Economic Survey, publications of Federal Bureau of Statistics and Annual Reports, State Bank of Pakistan.

Various functional forms have been tested to check the relationship between education, poverty, physical capital and economic growth in Pakistan. The most appropriate functional forms of the interested variables were specified as:

$$\ln\text{RGDP} = \gamma_0 + \gamma_1\text{Edu} + \gamma_2\text{PC} + \gamma_3\text{Pov} + \varepsilon_1 \quad (\text{A})$$

$$\text{Pov} = \beta_0 + \beta_1\ln\text{RDGP} + \beta_2\text{PC} + \beta_3\text{Edu} + \varepsilon_2 \quad (\text{B})$$

$$\text{Edu} = \alpha_0 + \alpha_1\ln\text{RDGP} + \alpha_2\text{PC} + \alpha_3\text{Pov} + \varepsilon_3 \quad (\text{C})$$

Where

- ln = Natural logarithm
- RGDP = Real gross domestic product, a proxy used to measure economic growth. RGDP proxy for economic growth has been already used by Katircioglu (2009), Chaudhary, Iqbal & Gillani (2009), Jin (2008), Abbas & Peck (2007), Islam, Wadud & Islam (2007), Afzal, Butt, Rehman & Begum (2009), Afzal *et al.* (2010) and Afzal, Rehman, Farooq and Sarwar (2011).
- PC = Physical capital in real terms; Gross fixed capital formation deflated by GDP deflator. This proxy for real physical capital has been already used by Chaudhary, Iqbal & Gillani (2009), Khorasgani (2008), Abbas & Peck (2007) and Afzal, Butt, Rehman & Begum (2009), Afzal *et al.* (2010) and Afzal, Rehman, Farooq and Sarwar (2011).
- Pov = Poverty; which is measured by Head Count Index. This measure for chronic poverty is widely used by Afzal *et al.* (2010), Amjad & Kemal (1997) and Vu & Baulch (2011).
- Edu = Education; different indicators of education are being used in literature to measure the effect of education *e.g.* school enrollment, college enrollment, university enrollment, total enrollment in all educational institutions and total expenditures on education. These measures do not capture the whole effect of education. So, the present research work uses a more comprehensive measure of education *i.e.* education index. Education index was constructed by using UNDP methodology developed in 1999-2000 for the period of 1971-72 to 2009-10. In education index, adult literacy rate (ALR) with two-thirds weighting and the combined primary, secondary, and tertiary gross enrollment ratio (GER) with one-third weighting are added together. This measure for education is already used by Afzal, Rehman, Farooq and Sarwar (2011).

$$\text{Education Index} = \frac{2}{3} * ALI + \frac{1}{3} * GEI$$

$$\text{Adult Literacy Index (ALI)} = \frac{ALR - \min}{\max - \min}$$

$$\text{Gross Enrollment Index (GEI)} = \frac{GER - \min}{\max - \min}$$

### ***Unit Root Tests***

It is prerequisite to make sure that none of the variables is integrated of order 2 (I(2)) or higher order while applying the ARDL approach to cointegration, because the calculated F-Statistic doesn't remain valid in the presence of I(2) or higher orders (Ouattara, 2004; Yildirim & Sezgin, 2003). So, testing the unit root is very crucial before estimating the ARDL model. For this purpose, the present study uses various unit root tests to check the robustness of the results. Augmented Dicky-Fuller (ADF), Phillips-Perron (PP) and Ng-Perron unit root tests are being used in this study. Unit root test given by Ng-Perron (2001) is considered most suitable for the small set of data compare to other tests. This test does not over reject the null hypothesis of unit root (Omisakin, 2008; Sinha, 2007; Ng-Perron 2001).

### ***Auto-Regressive Distributed Lag (ARDL) Approach to Cointegration***

Many a tests and approaches such as Engle-Granger (1987) residual based test, Johansen (1988, 1991), Johansen & Juselius (1990) Maximum Likelihood based test and Gregory & Hansen (1996) are commonly used in literature for conducting the co-integration. However, these techniques face many problems like low power and stationarity problems. These tests do not capture the effect of small data set. To overcome the above said problem, the present study applied the Auto-Regressive Distributed Lag (ARDL) Approach to co-integration proposed by Pesaran & Pesaran (1997) and Pesaran & Shin (1995, 1999). Pesaran *et al.* (2001) further extended the ARDL approach to co-integration. ARDL have superiority on other co-integration techniques. *Firstly*, it can be applied when the variables are of I(0) or I(1) or mutually integrated, but still it is pre-requisite that none of the variable is of I(2) or higher order. *Secondly*, it take care the problem of endogeneity. *Thirdly*, applying ARDL is helpful in data generating process through taking sufficient number of lags general-to-specific modeling framework. *Fourthly*, comparing to other VAR models, ARDL technique to co-integration can accommodate greater number of variable. *Finally*, ARDL approach performs better and gives more robust results in case of small data set. Banerjee *et al.* (1993) state that a dynamic Error Correction Model (ECM) can be derived from ARDL through a simple linear transformation. ECM gives the SR coefficient without losing the LR information.

Different causality techniques such as Granger (1969), Engle & Granger (1987) and Johansen & Juselius (1990) are present in literature but they are not free

from certain limitations. The present research utilizes a relatively more robust causality approach known as Toda-Yamamoto Augmented Granger Causality (TYAGC) Approach (1995). A brief introduction of TYAGC Approach is given below.

### ***Toda-Yamamoto Augmented Granger Causality (TYAGC) Approach***

Various tests are present to check the causality among variables *i.e.* Granger (1969), Engle & Granger (1987) and Johansen & Juselius (1990). These tests are not free from errors like they require stationarity requirements, selection of maximum lag length and they are very sensitive to model specification. It is necessary to pre test the unit root and cointegration while applying these tests. To overcome these problems, the present study applies a more robust causality technique given by Toda Yamamoto (1995) and it is further explained by Rambaldi & Doran (1996) and Zapata & Rambaldi (1997). The Augmented Granger Causality Approach given by Toda Yamamoto (1995) is very simple to apply and it also follows asymptotic Chi-square distribution. The major advantage of above said approach is that, in this technique, it is not necessary to check the pre testing of the order of integration or cointegration properties among variables (Toda Yamamoto, 1995; Dolado & Lütkepohl, 1996; Giles & Mirza, 1999). Rambaldi & Doran (1996) have modified Wald test that is considered more efficient when Seemingly Unrelated Regression (SUR) Model is used in the estimation. One of the attractiveness of using SUR is that it takes care of possible simultaneity bias in the system of equations.

### ***Empirical Results and their Interpretation***

In order to examine the relationship between education, poverty and RGDP, the ARDL approach to cointegration and TYAGC technique were applied. In this chapter, the results of different unit root tests, ARDL approach to cointegration and TYAGC are being presented.

#### **Unit Root Tests Results**

**Table 1 - Augmented Dickey-Fuller Test (ADF) and Phillips-Perron Test (PP)**

Variables	ADF		PP	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
ln RGDP	0.2 176 (0.9702)	-1 .7770 (0.6961)	0.2436 (0.9719)	-1.8979 (0.6360)
$\Delta$ ln RGDP	-6.6079 (.0000)		-6.5858 (0.0000)	
PC	-1.4718 (0.5365)	-3.2218 (0.0959)	-2.6895 (0.0851)	
Edu	0.4867 (0.9838)	-3.6859 (0.0357)	-0.2070 (0.9290)	-3.6769 (0.0364)
Pov	-2.5521 (0.1117)	-1.5558 (0.7916)	-2.5521 (0.1117)	-1.3691(0.8540)
$\Delta$ Pov	-5.4794 (0.0001)		-5.5183 (0.0000)	

Values in parentheses are p-values.

**Table 2 - Ng-Perron Unit Root Test**

Variables	MZA	MZT	MSB	MPT
ln RGDP with constant	-69.1798	-5.79221	0.08373	0.54860
PC with constant	-0.45631	-0.23224	0.50896	17.9009
PC with constant & Trend	-13.2438	-2.55003	0.19254	7.01110
$\Delta$ PC with constant	-9.93548	-2.22336	0.22378	2.48727
Pov with constant	-1.51851	-0.86979	0.57279	16.1009
Pov with constant & Trend	-2.07986	-0.78478	0.37733	31.7087
$\Delta$ Pov with constant	-17.7239	-2.95038	0.16646	1.47872
Edu with constant	0.57294	0.38139	0.66568	31.9970
Edu with constant & Trend	-18.359	-2.71839	0.18323	6.17264
1% level of significance with constant	-13.8000	-2.5800	0.1740	1.7800
5% level of significance with constant	-8.1000	-1.9800	0.2330	3.1700
10% level of significance with constant	-5.7000	-1.6200	0.2750	4500
1% level of significance with constant & trend	-23.8	-3.42	0.143	4.03
5% level of significance with constant & trend	-17.3	-2.9	0.168	5.48
10% level of significance with constant & trend	-120	-2.62	0.185	6.67

A summary of unit root results regarding order of integration base on different unit root criteria such as Augmented Dickey-Fuller Test (ADF), Phillips-Perron Test (PP) and Ng-Perron Test is given in Table 3.

**Table 3 - Order of Integration**

Variables	ADF		PP		Ng-Perron	
	Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Intercept & trend
RGDP	I(1)		I(1)		I(0)	
PC		I(0)	I(0)		I(1)	
Pov	I(1)		I(1)		I(1)	
Edu		I(0)		I(0)		I(0)

The order of integration of Pov and Edu is of I(1) and I(0) according to ADF, PP and Ng-Perron unit root tests, respectively. RGDP is I(1) according to ADF and PP unit root tests, while it is I(0) at Ng-Perron unit root test. According to ADF and PP unit root tests, the order of integration for PC is I(0), and it is I(1) at Ng-Perron unit root test. None of the variable is of I(2) according all criteria. So the best approach to cointegration is the ARDL approach to cointegration.

### Cointegration Results

To examine the SR and LR relationship between Edu, Pov, PC, and RGDP, the present research uses the Error-Correction version of ARDL model of equations (A), (B) and (C) by following Pesaran & Pesaran (1997) and Pesaran & Shin (1999) as:

$$\begin{aligned} \Delta \ln \text{RGDP} = & a_{0\text{RGDP}} + \sum_{i=1}^n b_{i\text{RGDP}} \Delta \ln \text{RGDP}_{t-i} + \sum_{i=0}^n c_{i\text{RGDP}} \Delta \text{PC}_{t-i} + \\ & \sum_{i=0}^n d_{i\text{RGDP}} \Delta \text{Pov}_{t-i} + \sum_{i=0}^n e_{i\text{RGDP}} \Delta \text{Edu}_{1t-i} + \delta_{1\text{RGDP}} \ln \text{RGDP}_{t-1} + \\ & \delta_{2\text{RGDP}} \text{PC}_{t-1} + \delta_{3\text{RGDP}} \text{Pov}_{t-1} + \delta_{4\text{RGDP}} \text{Edu}_{1t-1} \end{aligned} \quad (1)$$

$$\begin{aligned} \Delta \text{Edu} = & a_{0\text{Edu}} + \sum_{i=1}^n b_{i\text{Edu}} \Delta \text{Edu}_{1t-i} + \sum_{i=0}^n c_{i\text{Edu}} \Delta \text{PC}_{t-i} + \\ & \sum_{i=0}^n d_{i\text{Edu}} \Delta \ln \text{RGDP}_{t-i} + \sum_{i=0}^n e_{i\text{Edu}} \Delta \text{Pov}_{t-i} + \delta_{1\text{Edu}} \text{Edu}_{1t-1} + \\ & \delta_{2\text{Edu}} \text{RPC}_{t-1} + \delta_{3\text{Edu}} \ln \text{RGDP}_{t-1} + \delta_{4\text{Edu}} \ln \text{Pov}_{t-1} \end{aligned} \quad (2)$$

$$\begin{aligned} \Delta \text{Pov} = & a_{0\text{Pov}} + \sum_{i=1}^n b_{i\text{Pov}} \Delta \text{Pov}_{t-i} + \sum_{i=0}^n c_{i\text{Pov}} \Delta \text{PC}_{t-i} + \\ & \sum_{i=0}^n d_{i\text{Pov}} \Delta \ln \text{RGDP}_{t-i} + \sum_{i=0}^n e_{i\text{Pov}} \Delta \text{Edu}_{1t-i} + \delta_{1\text{Pov}} \text{Edu}_{1t-1} + \\ & \delta_{2\text{Pov}} \text{PC}_{t-1} + \delta_{3\text{Pov}} \ln \text{RGDP}_{t-1} + \delta_{4\text{Pov}} \text{Pov}_{t-1} \end{aligned} \quad (3)$$

**Table 4 – Cointegration Results**

Dependent variable	Lag length				Results
	1	2	3	4	
When RGDP is dependent variable					
$\Delta \ln \text{RGDP}$ [ $F_{\ln \text{RGDP}}$ (lnRGDP/PC, Pov, Edu)]	1.2096 [0.324]	2.6946 [0.064]	3.7899 [0.022]	6.2612 [0.002]	Cointegration
When Edu is dependent variable					
$\Delta \text{Edu}$ [ $F_{\text{Edu}}$ (Edu/PC, Pov, lnRGDP)]	3.9238 [0.018]	5.5539 [0.004]	2.1995 [0.111]	0.8574 [0.475]	Cointegration
When Pov is dependent variable					
$\Delta \text{Pov}$ [ $F_{\text{Pov}}$ (Pov/PC, Edu, lnRGDP)]	0.7852 [0.512]	0.5982 [0.621]	2.3235 [0.097]	5.6145 [0.004]	Cointegration

Lower and upper critical values for bounds testing ARDL for 1%, 5% and 10% significance levels are 3.65-66, 2.79-3.67 and 2.37-3.20, respectively.

The ARDL bound testing approach is applied to examine the cointegration through conducting F-statistic. The results of cointegration are presented in Table 4.

The results of F-Statistic in table 4 show that there exist cointegration between RGDP, Edu, Pov and PC when each of the RGDP, Edu and Pov serves as the dependent variable.

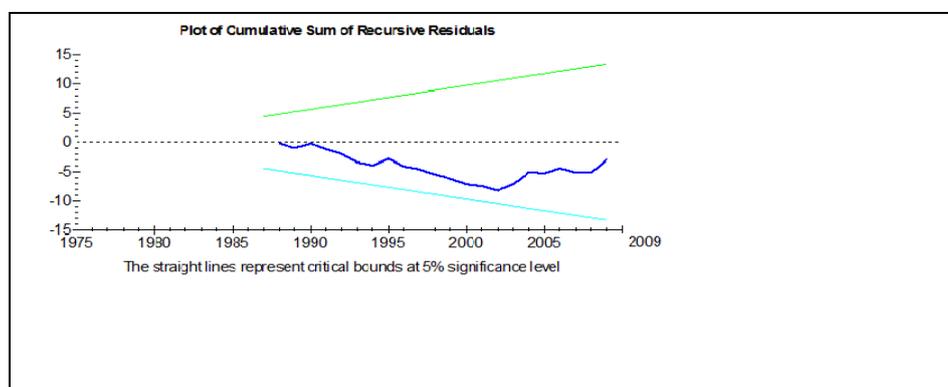
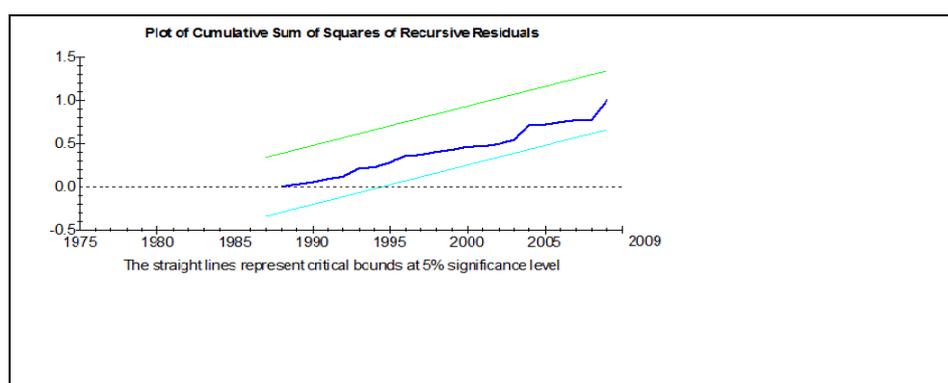
The results of dynamic model, stability of the model, the LR estimated coefficients and the Error Correction Model (ECM) for the lnRGDP, Pov, PC and Edu were estimated. The dynamic ARDL estimates based on Schwarz Bayesian Criterion (SBC) for the variable lnRGDP are presented in Table 5.

**Table 5 - Dynamic ARDL Model Based on SBC**

Model ARDL (1,0,3,4)		
Regressor	Coefficient	t-value (P-value)
LnRGDP(-1)	0.8049	12531(0.000)
lnPC	0.5887	2.2127 (0.037)
lnPov	0.6052	0.3340 (0.741)
lnPov(-1)	-0.0045	-2.0139 (0.056)
lnPov(-2)	0.0020	0.9589 (0.348)
lnPov(-3)	-0.0043	-2.4170 (0.024)
lnEdu	0.0030	1.6855 (0.105)
lnEdu(-1)	0.0009	0.5023 (0.620)
lnEdu(-2)	0.0032	1.5964 (0.124)
lnEdu(-3)	-0.0042	-1.8139 (0.083)
lnEdu(-4)	0.0098	5.2750 (0.000)
Constant	2.6473	3.4687 (0.002)
R <sup>2</sup> =99%	Diagnostic Tests:	
DW-value= 0.2251	Serial Correlation (LM) = 1.3234(0.250), Functional Form	
F-statistic = 3062.9	=1.8265(0.177)	
(0.000)	Normality (LM) = 0.7303(0.649), Heteroscedasticity (LM) =	
	2.9533 (0.086)	

The results of dynamic model in Table 5 reveal that the coefficients of lnRGDP(-1), PC, Pov(-1), Pov(-3), Edu, Edu(-2), Edu(-3) and Edu(-4) seem to be significant and helpful in explaining lnRGDP. The diagnostic tests results in table 5 show that the model for lnRGDP qualifies all the diagnostic tests. The model is free from the problems of Serial Correlation, and Heteroscedasticity.

Stability of the model is checked through the graphs of CUSUM and CUSUM Squares tests in Figures 1 and 2. The CUSUM and CUSUM Squares tests confirm that the model is stable as the calculated line lies inside the critical bounds at 5 percent level of significance. If the lines cross the critical bounds then the proposed model is unstable. The results in figures 1 and 2 show that the lines are within the critical bounds, so model is statistically stable. It can also be concluded that there is no structural break in the model being studied. This model can be used for prediction or forecasting or other policy purposes.

**FIGURE 1****Plot of Cumulative Sum of Recursive Residuals****FIGURE 2****Plot of Cumulative Sum of Squares Recursive Residuals**

After conducting the CUSUM and CUSUM Squares stability test, the results of LR coefficients of ARDL (3, 0, 0) for the variable  $\ln GDP$  are given in Table 6.

**Table 6 - Estimated LR Coefficients of ARDL (3, 0, 0) Model, Using the ARDL Approach and SBC (Dependent Variable = lnRGDP)**

Regressor	ARDL (3, 0, 0)	
	Coefficient	t-value (P-value)
PC	0.00003	1.9387 (0.065)
Pov	-0.0321	-5.8196 (0.000)
Edu	0.06516	12.8190 (0.000)
Constant	13.5662	46.5107 (0.000)

The LR coefficients of PC and Edu are positive and significant. This implies that an increase in PC and Edu lead to higher RGDP in the LR. The LR coefficient of Pov is negative and significant, means that lesser Pov leads to more RGDP and vice versa. The result of Error Correction Mechanism (ECM) is reported in Table 7.

**Table 7 - ECM Representation for Selected ARDL (3, 0, 0) Model Based on SBC (Dependent Variable = lnRGDP)**

Regressor	ARDL (3,0,0)	
	Coefficient	t-value (P-value)
dPC	0.00006	2.2127 (0.036)
dPov	0.0006	0.3340 (0.741)
dPov <sub>1</sub>	0.0023	1.1166 (0.275)
dPov <sub>2</sub>	0.0043	2.4170 (0.023)
dEdu	0.0030	1.6855 (0.104)
dEdu <sub>1</sub>	-0.0088	-3.5031 (0.002)
dEdu <sub>2</sub>	-0.0055	-2.5317 (0.018)
dEdu <sub>3</sub>	-0.0098	-5.2750 (0.000)
Constant	2.6400	3.4687 (0.002)
ECM(-1)	-0.1951	-3.4557 (0.002)
ECM = lnRGDP - 0.00000301PC + 0.0321Pov - 0.06515Edu - 13.5662		

Diagnostic Test Statistics:

R<sup>2</sup>= 71% ,F-value = 6.5677(0.000), DW-Statistic = 2.2251

The one period lag Error Correction term (ECM (-1)) captures the adjustment towards the long-run equilibrium. ECM (-1) coefficient specified the speed of adjustment back to long-run equilibrium after a short-run shock. ECM (-1) is highly significant with negative sign, indicating the establishment of cointegration and long-run causality among Edu, Pov, PC and RGDP. The coefficient of one period lagged ECM suggests that adjustment process is slow and 20 percent of the previous year's disequilibrium in RGDP from its equilibrium path will be improved in the current year. The SR effect of PC on RGDP is positive and significant. The two periods lagged SR effect of Pov on RGDP has been found surprisingly positive and

significant. One to three periods lagged SR effect of Edu on RGDP has been found negative and significant. This may be due to the fact that current investment in education leads to less capital for RGDP.

*In conclusion*, Both the SR and LR effect of PC on RGDP has been found to be positive and significant. Edu affects RGDP positively and significantly only in the LR. The Pov and RGDP are inversely and significantly related to each other in the LR.

### **Results of Toda Yamamoto Augmented Granger Causality (TYAGC) Technique**

The present study applies TYAGC approach to examine the causal nexus among Edu, Pov, PC and RGDP. For this purpose, the following sets of equations are being estimated. The estimated results of causality technique are presented in Tables 8.

$$RGDP_t = \alpha_{10} + \sum_{i=1}^3 \beta_{10i} RGDP_{t-i} + \sum_{i=1}^3 \gamma_{10i} PC_{t-i} + \sum_{i=1}^3 \lambda_{10i} Pov_{t-i} + \sum_{i=1}^3 \delta_{10i} Edu_{t-i} + u_{10t} \quad (4)$$

$$Edu_t = \alpha_{11} + \sum_{i=1}^3 \beta_{11i} RGDP_{t-i} + \sum_{i=1}^3 \gamma_{11i} PC_{t-i} + \sum_{i=1}^3 \lambda_{11i} Pov_{t-i} + \sum_{i=1}^3 \delta_{11i} Edu_{t-i} + u_{11t} \quad (5)$$

$$Pov_t = \alpha_{12} + \sum_{i=1}^3 \beta_{12i} RGDP_{t-i} + \sum_{i=1}^3 \gamma_{12i} PC_{t-i} + \sum_{i=1}^3 \lambda_{12i} Pov_{t-i} + \sum_{i=1}^3 \delta_{12i} Edu_{t-i} + u_{12t} \quad (6)$$

The results presented in Table 8 indicate that Edu Granger causes RGDP, while RGDP does also Granger cause Edu. Form this, it can easily be concluded that there exists bi-directional causality between Edu and RGDP. The null hypothesis that RGDP does not Granger cause Pov is also rejected at 1% level of significance. Pov also Granger causes RGDP at 1% level of significance. So, bidirectional causality has been observed between RGDP and Pov. The results in Table 8 also reveal bi-directional causality between Edu and Pov. It is also observed that PC is causing each of RGDP, Edu and Pov. *In conclusion*, there exists feedback causality between Edu and RGDP, between RGDP and Pov and between Edu and Pov. From here, one can easily conclude that there exists a strong LR relationship among Edu, RGDP, and Pov. There is a dire need of pro-poor growth and pro-poor education in Pakistan. Growth in Pakistan must be translated into education enhancement and poverty reduction activities. Growth and education that generates income and employment for the poor of the country can be critical for poverty reduction. Poverty can also be reduced by introducing social safety programs to the lower socio-economic segment of Pakistan's society. The government of Pakistan may alleviate poverty, promote education and accelerate economic growth by introducing "Conditional Cash

Transfers Programs” to the lower segment of the Pakistan’s society. Cash should be given only to those who send their children to schools. In this way, on one side, economic growth and enrollment can be enhanced and on the other side, poverty can be reduced. “Conditional Cash Transfers Programs” have been very successful in raising enrollment and reducing poverty in Mexico, Bangladesh and Brazil.

**Table 8 - Tetrivariate TYAGC Results**

Equations	Null Hypothesis	Test Statistic		
		Wald test ( $\chi^2$ -statistic)		
		Value	df	Prob.
<i>RGDP, PC, Pov and Edu</i>				
Equation 4	Edu does not Granger cause RGDP	7.9112 [0.005]	1	<i>Reject H<sub>0</sub></i>
Equation 4a	Pov does not Granger cause RGDP	18.3011 [0.000]	1	<i>Reject H<sub>0</sub></i>
Equation 4b	PC does not Granger cause RGDP	3.4175 [0.065]	1	<i>Reject H<sub>0</sub></i>
Equation 5	RGDP does not Granger cause Edu	41.2432 [0.000]	1	<i>Reject H<sub>0</sub></i>
Equation 5a	Pov does not Granger cause Edu	17.4900 [0.000]	1	<i>Reject H<sub>0</sub></i>
Equation 5b	PC does not Granger cause Edu	7.5038 [0.006]	1	<i>Reject H<sub>0</sub></i>
Equation 6	Edu does not Granger cause Pov	2.9846 [0.084]	1	<i>Reject H<sub>0</sub></i>
Equation 6a	RGDP does not Granger cause Pov	11.3870 [0.001]	1	<i>Reject H<sub>0</sub></i>
Equation 6b	PC does not Granger cause Pov	7353 [0.030]	1	<i>Reject H<sub>0</sub></i>

## Conclusion and Recommendations

Investing in education is the key to economic growth process. Education helps in reducing poverty and improving the socio-economic status of both the individuals as well as the society. The present research work explores the short-run (SR), long-run (LR) linkages and causal nexus among education, poverty and economic growth in the presence of physical capital as a fourth important variable. The SR and LR relationship among variables has been examined through Bounds Testing Approach to Cointegration and causality is tested through Toda-Yamamoto Augmented Granger Causality (TYAGC) approaches. The cointegration results confirm that there exist LR relationship among education, poverty, physical capital and economic growth, when each of the economic growth, education and poverty serves as the dependent variable. Both the SR and LR effect of PC on RGDP has been found to be positive and significant. Edu affects RGDP positively and significantly only in the LR. Better education can be an effective tool for reducing poverty and enhancing economic growth in Pakistan. The Pov and RGDP are inversely and

significantly related to each other in the LR. On one side, poverty must be reduced to accelerate economic growth and on the other side, economic growth must be enhanced to reduce poverty. The success of poverty reduction depends upon economic growth of the country as well as the manner in which the income of the country is distributed. The economic growth of Pakistan has not always been pro-poor, though poverty reduction did occur in the mid of first decade of 21<sup>st</sup> century. Growth in Pakistan was not translated in education enhancing and poverty reducing modes.

The coefficient of the ECM suggests that adjustment process is slow and 20 percent of the previous year's disequilibrium in RGDP from its equilibrium path will be improved in the current year. The CUSUM and CUSUM Square tests confirm that the model is statistically stable and no structural break found in model. The results of Toda Yamamoto Augmented Granger Causality Tests confirm the bidirectional causality between education and economic growth, between economic growth and poverty, and between education and poverty. Physical capital is causing each of the economic growth, poverty and education. The effect of education is more on economic growth rather than the effect of poverty on economic growth. Physical capital seems to a very helpful variable in explaining the education, economic growth and poverty linkages.

On the basis of the findings of the study, it is recommended that the government and other policy makers should focus on SR as well as LR solutions of poverty reduction. Government should make such policies that reduce the poverty in the SR as well as in the LR. The study also recommends pro-poor growth and education in Pakistan. Growth in Pakistan must be translated into education enhancement and poverty reduction activities. Growth and education that generates income and employment for the poor of the country can be critical for poverty reduction. Poverty can also be reduced by introducing social safety programs to the lower socio-economic segment of Pakistan's society. Government should also focus on the quantity and quality of education that, in turn, leads to more researches in the country. It is also recommended that the linkages among education, poverty and economic growth may further be explored and generalized by including other macroeconomic variables other than physical capital. Poverty reduction and education enhancing strategies must be adopted to accelerate economic growth of the country.

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