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Education and Economic Growth in Pakistan (1970-2011)

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ABSTRACT: *The objective of present study is twofold; first to analyze the effect of human capital, represented by different levels of education, on economic growth, second to evaluate the effect of effective labour on economic growth. By employing ARDL approach we conclude that higher education highly effect the economic growth. While effective labour remains highly significant in affecting the growth at all levels of education which follows that investment in human capital is important for developing countries like Pakistan.*

KEY WORDS: *Human Capital, Education, Economic Growth, Effective Labour, ARDL Approach*

I. INTRODUCTION

The increase in the amount of capital, plants and natural resources is normally considerd as a necessary condition for economic growth and development. While the non – physical and non-material capital like education, training, improvement in health and better housing and clean water facilities etc are accorded as sufficient condition for economic growth and development. Quality development of labor force generates new products or ideas that underlie technological progress. Human capital affects growth not only directly – influencing the rate of technological innovation of a country, but also indirectly – influencing the pace of adoption of technologies that come from the outside.

Schultz (1961) discussed the theoretical importance of human capital and provided a complete analysis of various aspects of human resources. He also examined the relationship between human capital and economic growth. Becker (1964) engaged more in statistical research and estimated empirically the rates of return to investment people had made themselves or in their own skills and efficiency, through schooling and training. However, Schultz and Becker were not first economists to highlight the role of human capital in economic growth and development economists have known it for long that people are an important part of productive capital. The Adam Smith (1776) in his inquiry in to the Nature and Causes of Wealth of Nations, mentioned quite clearly about the role of human capital in economic development.

Later in 19th century economists like Engel (1883) and Nicholon (1891) have argued the investment in human resources as a productive factor and an addition to the stock of capital that a nation holds. Then earlier in this century Fisher (1906), Marshall (1930), Friedman and Kuznets (1945) along-with many other economists have contributed to the development of the theory of human capital. All of them have discussed the relevance and importance of human capital as a factor of production. Eventually, the debate among economists shifted during the 1980s to the impact of technology, combined with knowledge and skills, on economic growth. Technology could not be seen separately from the human inputs who create them or who utilize them. Although the idea of inseparability between technology, - and particularly technology diffusion-, and human inputs had already been expressed in the economics literature in the 1960s and 1970s (Cipolla, 1965; Rosenberg, 1970; Mansfield, 1975), it was only in the mid-1980s that the issue became seriously taken up by most economists. Human capital consists of various activities. Schultz has analyzed five major activities that improve human capabilities. These are health, training, adult literacy, formal education. Some researchers consider nutrition and experience as productivity raising factors of human capital. Education is commonly regarded as the most important form of investment in human resources. It is also known that education has direct and positive effects on economic growth. Schultz (1961) in explaining the sources of economic growth suggests that investment in education accounts for a substantial proportion of growth. Other things equal the more educated a nations workers the greater their potential to catch up with prevailing technologies and to achieve more rapid output growth.

The main objectives of our study are as follows:

- Analyzing the effects of human capital on economic growth.
- Analyzing and estimating the effects of effective labour input on economic growth.
- To provide suitable policy implications based on empirical findings.

The study has been structured into five sections. After brief introduction we move to section 2 which briefly discuss the education sector in Pakistan, section 3 include the review of literature of the study. Section 4 has model specification, data and methodology used in this research work. In section 5 we have presented estimation and results and in last section we have discussed conclusion and policy implication.

II. EDUCATION SECTOR IN PAKISTAN

Recent Performance:

The primary objective of government policy in the last few years has been to improve the level and quality of education in Pakistan. The government vision is to expand primary education and this measure can be used to assess whether government schools have increased their coverage, by increasing enrolments faster than the growth in population. Literacy and primary school enrolment rates in Pakistan have shown improvement during last five years but they are still lagging behind other countries of the region. Scarcity of resources and inadequate provision of facilities and training are the primary obstacles in imparting and expanding education. The present government's strategy for the sector includes improving the functioning and utilization of existing schools, improving the quality of education, increasing enrolment, improving access to education and expanding the primary education system.

Educational Institutions and Enrolment

i) Primary Education (Classes I – V)

A total of 155,495 Primary Schools with 440,523 Teachers were functional in 2010-11. An increase in primary enrolment (19.16 million) over 2009-10 (18.77 million) was observed during 2010-11. It is estimated to increase by 2.2 percent to 19.57 million in 2011-12.

ii) Middle Education (Classes VI-VIII)

A total of 41,951 middle schools with 334,984 teachers were functional in 2010-11. An increase in middle enrolment (5.64 million) in 2010-11 over 2009-10 (5.50 million) has been observed during 2010-11. It is estimated to increase by 1.3 percent (5.72 million) in 2011-12.

iii) Secondary Education (Classes IX-X)

A total of 25,209 secondary schools with 452,779 teachers were functional in 2010-11. An increase in secondary enrolment (2.63 million) in 2010-11 over 2009-10 (2.58 million) has been observed during 2010-11. It is estimated to increase by 3.6 percent to 2.73 million in 2011-12.

iv) Universities Education (Classes XV onwards)

An enrolment of 1.41 million is estimated in 2011- 12 in higher education (universities) over 1.11 million in 2010-11. There are 135 universities with 63.557 thousand teachers in both private and public sectors are functional during 2010-11.

The overall educational situation, based on key indicators such as likely enrolments, number of institutes and number of teachers, has shown a slight improvement. The number of enrolments during 2010-11 was 39.9 million as compared to 38.2 million during the same period last year. This shows an increase of 4.4 percent. It is estimated to increase to 41.6 million during 2011-12.

III. REVIEW OF LITERATURE

There are many studies available regarding the sources of growth. Khan Zaheer et. Al (2011), empirically investigated the impact of education expenditures on economic growth of Pakistan for the time period 1980-2009. They used cointegration and error correction test to estimate the model. The results show that in long run physical capital and labour force participation affect the economic growth. Education has a long run relationship with economic growth, while in short run it is not significant. error correction term shows that 35% error correction has taken place from previous period to current period.

Qadri Sultan et.al (2011) analysed the effect of human capital on economic growth using time series data for Pakistan from 1978-2007. They used Cob-Douglas production function to test the long run relationship between human capital and economic growth. The regression results support the findings of previous studies that human capital is positively related to economic growth. Health adjusted education index is highly significant with economic growth which shows that both sectors are important for economic growth.

Khan Mohsin (2005), analyzed the impact of human capital on economic growth in Pakistan. The results of regression analysis suggest that Pakistan could increase its rate of economic growth by investing more

in its human capital. Higher levels of education and better health care results in a more productive work force, increasing total factor productivity and pushing a country's production function outward.

Abbas (2001), determined empirically the role of human capital in economic growth, a comparative analysis of two developing countries, Pakistan and Srilanka. The results show that human capital represented by primary schooling enrolment rates has a negative impact on economic growth for Pakistan and Sri Lanka. Human capital proxied by secondary schooling enrolment rates has a positive and significant impact on growth for both countries in the sample. Moreover, human capital measured by higher schooling enrolment rates has also a positive impact on economic growth for Pakistan and Sri Lanka.

Abbas (2000), made a comparative analysis of two developing countries, Pakistan and India, for the period 1970 to 1994. The main objective of this study is to estimate and analyze the effects of human capital on economic growth. The results of Empirical Analysis show that human capital represented by primary schooling enrolment rates has a positive impact on economic growth for India only. Human capital proxied by secondary schooling enrolment raters has a positive and significant impact on growth for both countries in the sample. But human capital measured by higher schooling enrolment rates has a positive impact on economic growth for Pakistan, while it effects negatively to growth for India.

Iqbal and Zahid (1998) examined the effects of some of the key macroeconomic variables on Pakistan's economic growth. The estimated coefficients of enrolments in secondary schools, high schools, and other educational institutions as ratios to total employed labor force remain statistically insignificant with unexpected negative signs. Output growth is affected positively by exports more than by imports. Increased openness to international trade promotes growth because of the increased availability of technologies accompanying knowledge spillovers. Human capital (defined as primary schools enrolment as a ratio to total employed labor force) has the largest positive absolute and relative impact.

Chou and Wong (2001), estimated the major factors of growth of Hong Kong. The growth factors that are found to be important for Hong Kong are physical capital accumulation, (negative) growth of unskilled workers, education, technology` spillover (from foreign countries) through retained import of capital goods and inward direct investment and learning-by-doing through import and domestic manufacturing production. The results show that the output per worker, capital per worker, working population, education expenditure, secondary school enrollment ratio, learning-by-doing, and foreign direct investment are co-integrated. Education expenditure and learning-by-doing are better

IV. MODEL SPECIFICATION:

First a functional form is assumed for the aggregate production, where output is a function of traditional production factors i.e. capital stock, labor and human capital.

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} H_t^{\gamma} e_t \qquad \text{(A)}$$

A_t represent technology which is treated as constant in the model. α, β and γ are the elasticities (responsiveness) of output with respect to capital, labor and human capital respectively.

Taking log of variables we get the following equation :

$$\ln Y_t = \ln A_t + \alpha \ln K_t + \beta \ln L_t + \gamma \ln H_t + \ln e_t$$

Where $\ln A_t = a$ and $\ln e = e_t$

$$\ln Y_t = a + \alpha \ln K_t + \beta \ln L_t + \gamma \ln H_t + e_t$$

We estimate the above equation for three levels of human capital, proxied as enrolment at primary, secondary and university level.

$$\ln Y_t = a + \alpha \ln K_t + \beta \ln L_t + \gamma \ln PRI_t + e_t \qquad (1)$$

$$\ln Y_t = a + \alpha \ln K_t + \beta \ln L_t + \gamma \ln SEC_t + e_t \qquad (2)$$

$$\ln Y_t = a + \alpha \ln K_t + \beta \ln L_t + \gamma \ln UNI_t + e_t \qquad (3)$$

b) Human capital embodied labour as a factor of production:

We combine a human capital measure and labour force to create effective labour input. Because we know that human capital embodied labour performs better than traditional labour in estimating output growth. So aggregate production function can be written in the following form.

$$Y_t = A_t K_t^{\alpha} (L_t H_t)^{\beta} e_t \qquad \text{(B)}$$

Taking log of variables we have

$$\ln Y_t = \ln A_t + \alpha \ln K_t + \beta (\ln L_t + \ln H_t) + \ln e_t$$

Where $\ln A_t = a$ and $\ln et = e_t$

$$\ln Y_t = a + \alpha \ln K_t + \beta (\ln L_t + \ln H_t) + e_t$$

Estimating the above equation at all education levels.

$$\ln Y_t = a + \alpha \ln K_t + \beta (\ln L_t + \ln PRI_t) + e_t \qquad (4)$$

$$\ln Y_t = a + \alpha \ln K_t + \beta (\ln L_t + \ln SEC_t) + e_t \qquad (5)$$

$$\ln Y_t = a + \alpha \ln K_t + \beta (\ln L_t + \ln UNI_t) + e_t \qquad (6)$$

Coefficients represent the elasticities with respect to each specific variable and error term is denoted by e_t.

Calculation for the capital stock:

We measure the capital stock by perpetual inventory method. It argues that stock of capital is the accumulation of the stream of past investments.

$$K_t = K_{t-1}(1 - \delta) + I_t$$

Where (I) is the total investment in physical capital (t) denotes time period. This procedure requires information on depreciation rate (δ) and initial capital stock (K_{t-1}).

Capital stock for the starting period (1970) requires knowledge about the overall capital output ratio. Estimates of both the capital output ratio and depreciation rate are 3 and 5% respectively. Initial period's capital stock is calculated as:

$$K_{t-1} = K_t / Y_t * Y_t$$

Where (K_t/Y_t) is the capital output ratio and (Y_t) is output level in the initial period. The calculation of the capital stock for the remaining years uses the perpetual inventory method.

Data and sources:

This study takes into account the annual data from 1970-2011. In order to express the variables in real terms all of the variables except labor and human capital are deflated. GDP deflator deflates GDP and Investment, where by the year 2005 is treated as base year (2005=100). Furthermore, all of the series are transformed into log form. We take six-year lag incase of primary enrolment, four year and two year lag for secondary and higher education. Following sources of data have utilized:

- *Economic Survey of Pakistan*
- *Federal Bureau of Statistics*
- *State Bank of Pakistan*

V. ESTIMATION AND RESULTS

Results of Unit root test:

To further proceed towards estimation we now consider the order of integration (or stationary) of each series using the Augmented Dickey Fuller (ADF) unit root tests. The results (appendix1) of our study comprise that some variables have a unit root in their levels indicating that the levels are non-stationary while some are stationary at level. So we apply ARDL model which deals with both I(0) and I(1)

Results of ARDL cointegration approach:

a) Human Capital as a factor of production:

First of all we analyze the growth taking human capital as a factor of production with traditional factors of production, physical capital and labour. We estimate the equation using three levels of education, primary, secondary and university enrolment.

We estimate the error correction representation of ARDL model for testing the null of no co-integration. We impose lags on the first difference of each variable and compute the F-statistics for the joint significance of lagged level of variables. Regarding the choice of appropriate lag length we have used the Akaike's information criteria (AIC). The calculated F-statistics is compared with the critical value tabulated by Pesaran and Pesaran (1997) or Pesaran et al. (2001). Regarding the hypothesis testing for existence of long run relationship all the models included in the analysis provide the evidence for the existence of long run relationship.

Empirical evidence reveals that in the long run physical capital, labour and university education remains highly significant in effecting the economic growth. Theory also predicts that when we increase the physical capital stock (plant, machinery, and infrastructure investment) it leads to expansion in economic activities which in turn lead to increase in out put growth by increase in productivity, increase in employment opportunities, getting the benefits of economies of scale and by raising the overall welfare of country. Increase in labor force means the increase in the work age population of an economy that increases the output growth by participating in economic activities. Our empirical estimates are consistent with theory. A one percent increase in university education raises the economic growth by 0.14 percent point as shows the results of equation (3) in appendix. Contribution of university education is highly significant factor in effecting the economic growth. The reason might me that in Pakistan people that have access to higher education are only few so their contribution is small but they are highly significant in effecting the economic growth. Because they have high potential to grow in the long run and more opportunities are available to them to increase their productivity. Results imply that other things equal the more educated a nation's workers the greater their potential to catch up with prevailing technologies and to achieve more rapid output growth.

Primary education positively effects the economic growth but is insignificant as the results in equation (1) show. The reason might be that primary education does not provide any skill to labour. The chances of increase in productivity are less with only with primary level of education. So it contributes to growth but not an important factor for economic growth. Secondary education negatively effects the economic growth and also an insignificant factor as is shown by the results of equation (2). One reason might be the high drop out rates because all the students that get admission to school do not complete their schooling. As for as Pakistan is concerned the most important reason might be that in Pakistan the poverty level is very high and most of the parents send their children to work rather than putting them in schools. Moreover the returns to Secondary education are very low especially in case of urban formal sector.

The Short run co-efficient estimates obtained from the ECM indicate that the estimated lagged error correction term (EC_{t-1}) is negative and significant. The feedback coefficient is 3 percent in first three equations., suggesting that about 3 percent disequilibrium in the previous year is corrected in the current year. Primary education is negative and insignificant like the long run case. Secondary education is again negative and insignificant while university education is positive and significant in affecting the economic growth. Labour negatively contributes to economic growth. In the short run capital stock is highly significant in effecting the economic growth. While other variables lose their significance in the short run. One reason might be that affect of these variables on economic growth requires a long time span b/c economic growth is long time/time taking phenomena so they are not highly significant in the short run. Furthermore the model passes all the diagnostic tests. Overall explanatory power of the model is tested through R-squared, adj. R-squared and F.statistics.
It is concluded that when we treat human capital as a factor of production only university education positively and significantly contribute to economic growth while primary and secondary education remains insignificant.

b) Human capital embodied labour as a factor of production:

In the second step we analyze the growth combining human capital and labour as a factor of production with traditional factors of production, physical capital and labour. We estimate the equation using three levels of education, primary, secondary and university enrolment.

In the first step for testing the long run relationship b/w the variables we use Bounds Testing Approach, which involve testing the null hypothesis of no cointegration against the alternative of existence of cointegrating relation ships among the variables. Results show the existence of longrun relationships among the variables in the last three equations using effective labour force as a factor of production. Long run results show that there is significant improvement in the share of effective labour for all the measures of human capital as compared to simple schooling enrolment rates. For example, for primary schooling enrolment rates, it improves from 0.08 to 0.18 and for secondary schooling enrolment, it improves from -0.01 to 0.17, which are both significant

now. It implies that for Pakistan, human capital embodied labour performs better in estimating output growth as compared to simple schooling enrolment rates.

Short run co-efficient estimates obtained from the ECM version of ARDL model indicate that effective labour remain significant like the long run case except the secondary level of education. The error correction term is negative as expected and significant, -0.27, and -0.28 respectively considering primary and secondary education. While it is -0.39 considering the higher education. The highly significant error correction term show that deviation from long run growth path is corrected by around 0.27, 0.27 and 0.39 percent in each case over the following year. The highly significant error correction term indicates high speed of adjustments. The highly significant error correction term show that deviation from long run growth path is corrected by around 0.42, 0.65 and 0.49 percent in each case over the following year. Highly significant error correction term is a further proof of the existence of a stable long run relationship.
It is concluded that when we combine the human capital with labour it significantly contribute to economic growth at all levels of education.

VI. CONCLUSION AND POLICY IMPLICATION

Different studies have considered different factors to be more important for growth and development and different approaches have remained popular during different periods. The present study attempts to evaluate the impact human capital and effective labour on economic growth. Results of the present study are based on ARDL cointegration approach. We use a Cobb-Douglas specification that includes the traditional production factors capital stock as well human capital. We have divided our study into two different parts by using different measures of human capital and ways to contribute in economic growth. The results of Empirical Analysis i.e., growth accounting with human capital as a factor of production reveal that our basic model parameters physical capital and labor remains stable in general while incorporating human capital in growth analysis provides mix results. In the long run university education remains significant while primary and secondary education remains insignificant. Moreover, in the same part of the analysis, we have tried another measure for human capital i.e., we have combined the human capital measures (schooling enrolment at different levels of education) with labour in order to create effective labour input. So by applying this measure for human capital, we found that there are not only important growth effects associated with human capital, but also this measure out-performs the simple schooling enrolment rates for Pakistan. Effective labour force remains significant at all levels of education. We conclude that human capital show consistant behaviour when we interact it with labour. Short run results also support the long run results.

The results presented in this study reinforce the importance of sensible long run growth oriented policies to obtain sustain growth. The most important policy implication that stems from our analysis is regarding the role of human capital. It implies that primary and secondary education is an important prerequisite for accelerating growth therefore this must be considered as the foundation stone upon which the economic development of Pakistan can be erected. The government must provide primary and secondary education to all school age children to improve the literacy rate and also should provide the incentives to reduce the drop outs. Since higher education as a measure for human capital has significant impact on economic growth, the policy alternative should be to pay more attention to the areas where the facilities of higher education are inadequate. Human capital embodied labour effects positively and significantly to economic growth, so the policy alternative should be that government has to increase investment in training programmes for labour and technical education. Investment in human capital is important for developing countries like Pakistan because the economies with higher ratios of physical to human capital will always de-cumulate physical capital and economies with low ratios of physical to human capital will always increase their holdings of physical capita. This places human capital as a key factor for growth.

APPENDIX 1: Unit root test ADF Test Results

Variables	LEVEL			1st DIFFERENCE		
	Lags	Intercept	Trend & intercept	Lags	Intercept	**Trend & intercept**
LNY_t	0	-1.21 (-2.93)	-2.41 (-3.51)	0	-6.72* (-2.93)	**-6.67* (-3.51)**
LNK_t	1	-1.39 (-2.93)	-2.02 (-3.51)	1	-3.16* (-2.93)	**-3.77* (-3.51)**
LNL_t	0	-0.64 (-2.93)	-2.50 (-3.51)	0	-7.82* (-2.93)	**-7.82* (-2.93)**
$LNPRI_t$	0	-4.19* (-2.93)	-3.59* (-3.51)	0	-5.96* (-2.93)	**-5.88* (-3.51)**
$LNSEC_t$	0	-3.88* (-2.93)	-4.11* (-3.51)	0	-6.47* (-2.93)	**-4.11* (-3.51)**
$LNUNI_t$	**0**	**-2.73 (-2.93)**	**-2.32 (-3.51)**	**0**	**-6.05* (-2.93)**	**-6.34* (-3.51)**

Note: * denote the rejection of the null hypothesis at 5% level of significance.

Appendix 2: Cointegration (ARDL Approach)

a) <u>Human Capital as a factor of production</u>:

Primary enrolment as a level of education.

$$\Delta \ln Y = a_0 + a_1 \ln Y_{t-1} + a_2 \ln K_{t-1} + a_3 \ln L_{t-1} + a_4 \ln PRI_{t-1} + \sum_{i=1}^{m} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{m} \delta_i \Delta \ln K_{t-i} + \sum_{i=0}^{m} \gamma_i \Delta \ln L_{t-i} + \sum_{i=0}^{m} \lambda_i \Delta \ln PRI_{t-i} + \xi_t \quad \textbf{(1)}$$

<u>Bounds Test for Cointegration Analysis</u>

H0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ **H1:** $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq 0$

Critical Value	Lower Bound Value	Upper Bound Value
1%	**4.29**	**5.61**
5%	**3.23**	**4.35**
10%	**2.72**	**3.77****

Computed *F*-statistic: 4.06 ** Indicate significance at 10% level

<u>Estimated Long Run Coefficients</u>

ARDL(0,2,2,0) selected based on Akaike Information Criterion
Dependent variable is Y

Regressor	Coefficient	T-Ratio[Prob]
LNK	.43613	**2.6905*[.011]**
LNL	1.1041	**2.1986*[.035]**
LNPRI	.089193	**.52847[.601]**
C	**3.9688**	**2.5495[.015]**

*Indicate significance at the 5 percent level

Error Correction Model

ARDL(0,2,2,0) selected based on Akaike Information Criterion

Dependent variable is dY

Regressor	Coefficient	T-Ratio[Prob]
dLNK	2.9012	**5.3054*[.000]**
dLNL	-.56463	**-1.6095**[.116]**
dPRI	.029115	**.52162[.605]**
dC	1.2955	**2.2080[.034]**
ecm(-1)	-.32643	**-3.7656*.001]**
Diagnostic Test Statistics:		
R-Squared	**R-Bar-Squared**	**F-stat.F(6,36)10.6963[.000]**
.65369	**.57221**	**DW-stat 1.8242**
AIC	**SBC**	
96.5898	**88.6644**	

*, ** Indicate significance at the 1, 5 and 10 percent level.

Secondary enrolment as a level of education.

$$\Delta \ln Y = a_0 + a_1 \ln Y_{t-1} + a_2 \ln K_{t-1} + a_3 \ln L_{t-1} + a_4 \ln SEC_{t-1} + \sum_{i=1}^{m} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{m} \delta_i \Delta \ln K_{t-i} + \sum_{i=0}^{m} \gamma_i \Delta \ln L_{t-i} + \sum_{i=0}^{m} \lambda_i \Delta \ln SEC_{t-i} + \xi_t$$

(2)

Bounds Test for Cointegration Analysis

H0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ **H1:** $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq 0$

Critical Value	Lower Bound Value	Upper Bound Value
1%	**4.29**	**5.61**
5%	**3.23**	**4.35**
10%	**2.72**	**3.77****

Computed *F*-statistic: 4.21 ** Indicate significance at 10% level.

Estimated Long Run Coefficients

ARDL(0,2,2,0) selected based on Akaike Information Criterion

Dependent variable is Y

Regressor	Coefficient	T-Ratio[Prob]
LNK	.43234	**2.5731*[.015]**
LNL	1.3338	**3.1004*[.004]**
LNSEC	-.011091	**-.091287[.928]**
C	**3.4525**	**2.0034[.053]**

* Indicate significance at the 1 and 5 percent level

Error Correction Model

ARDL(0,2,2,0) selected based on Akaike Information Criterion

Dependent variable is dY

Regressor	Coefficient	T-Ratio[Prob]
dLNK	2.7985	**5.2358*[.000]**
dLNL	-.49248	**-1.5144**[.139]**
dSEC	-.0035068	**-.092155[.927]**
dC	1.0916	**1.6429[.109]**
ecm(-1)	-.31619	**-3.4563*[.001]**
Diagnostic Test Statistics:		
R-Squared .65101	**R-Bar-Squared .56889**	**F-stat.F (6,36)10.5705[.000]**
AIC 96.4238	**SBC 88.4984**	**DW-stat 1.8440**

*, ** Indicate significance at the 1, 5 and 10 percent level

University enrolment as a level of education.

$$\Delta \ln Y = a_0 + a_1 \ln Y_{t-1} + a_2 \ln K_{t-1} + a_3 \ln L_{t-1} + a_4 \ln UNI_{t-1} + \sum_{i=1}^{m} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{m} \delta_i \Delta \ln K_{t-i} + \sum_{i=0}^{m} \gamma_i \Delta \ln L_{t-i} + \sum_{i=0}^{m} \lambda_i \Delta \ln UNI_{t-i} + \xi_t \quad \textbf{(3)}$$

Bounds Test for Cointegration Analysis

H0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ **H1:** $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq 0$

Critical Value	Lower Bound Value	Upper Bound Value
1%	**4.29**	**5.61**
5%	**3.23**	**4.35***
10%	**2.72**	**3.77****

Computed *F*-statistic: 4.85 *,** Indicate significance at 5% and 10% level.

Estimated Long Run Coefficients

ARDL(0,2,1,0) selected based on Akaike Information Criterion

Dependent variable is Y

Regressor	Coefficient	T-Ratio[Prob]
LNK	.73627	**4.9752*[.000]**
LNL	.31416	**1.7511**[.458]**
LNUNI	.14334	**2.1682*[.037]**
C	**2.7630**	**2.7704[.009]**

*,**Indicate significance at the 1,5 and 10 percent level

Error Correction Model

ARDL(0,2,1,0) selected based on Akaike Information Criterion

Dependent variable is dY

Regressor	Coefficient	T-Ratio[Prob]
dLNK	3.4185	**6.0219*[.000]**
dLNL	-.38472	**-1.2360**[.224]**
dUNI	.053644	**1.9488**[.059]**
dC	1.0340	**2.2897[.028]**
ecm(-1)	-.37424	**-4.0780*[.000**
Diagnostic Test Statistics:		
R-Squared .65976	**R-Bar-Squared .59171**	**F-stat.F (5,37)13.5737[.000]**
AIC 97.9699	**SBC 90.9251**	**DW-stat 1.9405**

*, ** Indicate significance at the 1, 5 and 10 percent level

b) Human capital embodied labour as a factor of production:

Primary enrolment as a level of education.

$$\Delta \ln Y = a_0 + a_1 \ln Y_{t-1} + a_2 \ln K_{t-1} + a_3 (\ln L + \ln PRI)_{t-1} + \sum_{i=1}^{m} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{m} \delta_i \Delta \ln K_{t-i} + \sum_{i=0}^{m} \lambda_i \Delta (\ln L + \ln PRI)_{t-i} + \xi_t$$

(4)

Bounds Test for Cointegration Analysis

H0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ **H1:** $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq 0$

Critical Value	Lower Bound Value	Upper Bound Value
1%	**5.15**	**6.36***
5%	**3.79**	**4.85***
10%	**3.17**	**4.14****

Computed *F*-statistic: 11.89 *, ** Indicate significance at 1%, 5% and 10% level.

Estimated Long Run Coefficients

ARDL (0, 2, and 0) selected based on Akaike Information Criterion

Dependent variable is Y

Regressor	Coefficient	T-Ratio[Prob]
LNK	.78530	**5.1570*[.000]**
LNL+LNPRI	.18291	**1.9620*[.057]**
C	**1.6434**	**.97416[.336]**

*Indicate significance at the 1 and 5 percent level

Error Correction Model

ARDL (0, 2,0) selected based on Akaike Information Criterion

Dependent variable is dY

Regressor	Coefficient	T-Ratio[Prob]
dLNK	3.3683	**6.5851*[.000]**
d(LNL+LNPRI)	.049477	**1.4596**[.153]**
dC	.44452	**.86288[.394]**
ecm(-1)	-.27049	**-3.1362*[.003]**
Diagnostic Test Statistics:		
R-Squared .57129	**R-Bar-Squared .51335**	**F-stat.F(4,38)12.3262[.000]**
AIC 95.0005	**SBC 89.7169**	**DW-stat 1.7368**

*, ** Indicate significance at the 1, 5 and 10 percent level

Secondary enrolment as a level of education.

$$\Delta \ln Y = a_0 + a_1 \ln Y_{t-1} + a_2 \ln K_{t-1} + a_3(\ln L + \ln SEC)_{t-1} + \sum_{i=1}^{m} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{m} \delta_i \Delta \ln K_{t-i} + \sum_{i=0}^{m} \lambda_i \Delta(\ln L + \ln SEC)_{t-i} + \xi_t$$

(5)

Bounds Test for Cointegration Analysis

H0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ **H1:** $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq 0$

Critical Value	Lower Bound Value	Upper Bound Value
1%	**5.15**	**6.36***
5%	**3.79**	**4.85***
10%	**3.17**	**4.14****

Computed *F*-statistic: 12.46 *,** Indicate significance at 1%, 5% and 10% level.

Estimated Long Run Coefficients

ARDL(0,2,1) selected based on Akaike Information Criterion

Dependent variable is Y

Regressor	Coefficient	T-Ratio[Prob]
LNK	.77758	**5.1240*[.000]**
LNL+LNSEC	.17342	**1.9361**[.061]**
C	**2.2988**	**1.1848[.244]**

*, ** Indicate significance at the 1 and 10 percent level

Error Correction Model

ARDL(0,2,1) selected based on Akaike Information Criterion

Dependent variable is dY

Regressor	Coefficient	T-Ratio[Prob]
dLNK	3.4887	**6.9014*[.000]**
d(LNL+LNSEC)	-.083060	**-1.1973[.239]**
dC	.64750	**.99985[.324]**
ecm(-1)	-.28167	**-3.1462*.003]**
Diagnostic Test Statistics:		
R-Squared .59476	**R-Bar-Squared .52722**	**F-stat.F (4,38)13.2093[.000]**
AIC 95.2114	**SBC 89.0472**	**DW-stat 1.7144**

* Indicate significance at the 1percent level

University enrolment as a level of education.

$$\Delta \ln Y = a_0 + a_1 \ln Y_{t-1} + a_2 \ln K_{t-1} + a_3 (\ln L + \ln UNI)_{t-1} + \sum_{i=1}^{m} \beta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{m} \delta_i \Delta \ln K_{t-i} + \sum_{i=0}^{m} \lambda_i \Delta (\ln L + \ln UNI)_{t-i} + \xi_t$$

(6)

Bounds Test for Cointegration Analysis

H0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ **H1:** $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq 0$

Critical Value	Lower Bound Value	Upper Bound Value
1%	**5.15**	**6.36***
5%	**3.79**	**4.85***
10%	**3.17**	**4.14****

Computed *F*-statistic: 14.48 *, ** Indicate significance at 1%, 5% and 10% level.

Estimated Long Run Coefficients

ARDL (0, 2, and 0) selected based on Akaike Information Criterion

Dependent variable is Y

Regressor	Coefficient	T-Ratio[Prob]
LNK	.80123	**13.4262*[.000]**
LNL+LNUNI	.15307	**4.8688*[000]**
C	**2.3374**	**2.7340[.010]**

*Indicate significance at the 1 percent level

Error Correction Model

ARDL (0,2,0) selected based on Akaike Information Criterion

Dependent variable is dY

Regressor	Coefficient	T-Ratio[Prob]
dLNK	3.5979	**7.5943*[.000]**
d(LNL+LNUNI)	.060438	**3.0621*[.004]**
dC	.92288	**2.2298[.032]**
ecm(-1)	-.39482	**-4.4211*[.000]**
Diagnostic Test Statistics:		
R-Squared .63827	**R-Bar-Squared .58939**	**F-stat.F (4,38)16.3217[.000]**
AIC 98.6533	**SBC 93.3697**	**DW-stat 1.8147**

*Indicate significance at the 1 percent level

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