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Tertiary Education and Economic Growth of Nepal: An ARDL-ECM Analysis

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Abstract

This study examined the relationship between tertiary schooling and economic growth in Nepal. The autoregressive distributed-lagged (ARDL) bound test for cointegration and error-correction method (ECM) were employed. Time series data of 1989/90 to 2018/19 were taken into consideration. Updated time series and ARDL bounds test were applied for cointegration with ECM analysis to estimate the aimed relationship between variable of interests. Economic growth (RGDP) as dependent variable, education (GERT) as a regressor, and controlled variables—physical capital, labor force, and *CPI*—were used. The results of the study revealed cointegration between education and economic growth, confirming their long-run relationship. The negative and significant ECT_{1-t} strengthened the presence of long-run relationship among RGDP and GERT. This study found tertiary schooling as a productivity enhancer of human capital in Nepal. Based on this finding, this study recommends promoting the tertiary schooling through adequate financing.

Keywords: cointegration, economic growth, education, error correction model, human capital, physical capital

***JEL classification*.** C21, C51, I21, I23, J24, J21

Introduction

Education plays a vital role in economic growth. Tertiary educational expenditure changes over time due to both supply and demand factors. Demand factors include the growth rate of national economy and the ranges of competing demands of other public services besides other things. Likewise, supply factors include demographic changes and the importance of education for national development (Tsang, 1995).

As an industry, education produces knowledge, which is an economic activity and influences economic development of a country in many ways, because changing economic and social conditions have given knowledge and skills to increase central

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role in the success of individuals and nations. Individuals derive knowledge and skills through education, popularly known as human capital. There is now robust evidence that human capital is a key determinant of economic growth (Paudel, 2008).

Nowadays, Nepal's agricultural economy is gradually shifting towards nonagricultural fields, such as computer services, tourism, trade and social service. They are growing along with urbanizations of the population. The urban sector becomes more inclined towards nonagricultural sector. Jobs have become more service oriented, and the government should provide such types of education that will enable them to adopt themselves to changing scenario of job opportunity and market. In order to make manpower production more employable, therefore, a pragmatic job orientation programmed from the tertiary education should be introduced so that the students can choose their future career right in time. Such activities contribute to the economic growth of the country (Singh, 2005).

Tertiary schooling plays a vital role directly and indirectly in the economic growth of the country. It is supported by various literatures. Several literatures investigated the link between education and economic growth. Barro (1991) and Mankiw et al. (1992) examined variations in school enrolment rates in both the industrialized and the less-developed countries, and they have concluded that schooling has a significantly positive relationship on the rate of growth of real GDP. Tertiary schooling and its attainment are directly interlinked with human capital. Thus, Odit, Dookhan, and Fauzel (2010) concluded that human capital plays a significant role in economic growth chiefly as an engine for improvement of the output level of the country. Education supports to develop the strong and well-disciplined citizens to a nation. Thus, education has a highly positive impact on economic growth (Lucas, 1988; Romer, 1986).

Education improves people's productivity and creativity, which promotes entrepreneurship and technological advances that plays a very crucial role in securing economic and social progress and improving income distribution (Ozturk, 2001). Chatterji (1998) mostly focused on tertiary education and economic growth found that the tertiary education may well have a crucial role to play in the growth process. Afzal et al. (2010) studied the ARDL bounds test for cointegration on the time-series data of Pakistan, and they found that significant two way direct long-run and two-way inverse relationship of school enrollment ratio as an education on Real GDP. Some of the literatures had evidence of a robust relationship between higher education and economic growth in the long run (Ali, Hakim, & Abdullah, 2016; Hanif, & Arshed, 2016; Mahmood & Shahab, 2010). Bils & Klenow (2000) and Self & Grabowsky (2004 found the schooling are highly correlated with economic growth. They concluded that high enrollment rate causes rapid improvement in productivity; therefore, faster growth in per capita income resulted in countries where there is high rate of enrollment in schools.

Gyimah-Brempong, Paddison, and Mitiku (2006), of their panel data over the 1960–2000 period to investigate the effect of higher education human capital on economic growth in African countries, found that all levels of education human capital, including higher education human capital, have positive and statistically significant effect on the growth rate of per capita income in African counties. A study of Lin (2004) revealed that higher education overall showed a positive and significant effect on Taiwan's economic development and that engineering and the natural sciences majors played the most prominent role in this process. Another evidence of Turkish economy discovered with ARDL bounds tests for cointegration revealed that the higher education is cointegrated to economic growth, and either higher education or economic growth has significant causal effects on each other (Erdem and Tuğcu, 2010).

A time series data analysis with ARDL model explored the cointegration and causality between education and economic growth in Pakistan. There was a cointegration among economic growth and education and causality between education, and all levels of education with economic growth was found. The study revealed that higher education highly causes economic most significant growth (Afzal, Rehman, Farooq, & Sarwar, 2011). Tasel and Bayarçelik (2013) examined the relationship between human capital as enrolment rates at different levels and economic growth found that the positive long-run relationship between human capital and economic growth.

Dahal (2010), in his causality analysis over the period of 1975–2009, found an evidence in favor of causality running from real gross domestic product to enrollment in tertiary education in Nepal. On the basis of the results of the OLS studies of education and economic growth during the period of 1993 to 2013, Dahal (2016) confirmed the existence of long-run relationship in education (a well-educated human capital) and Real GDP Per Capita in Nepal. They suggested keeping education on top priority in public policies to discourage the drop-out rate at all levels of education to achieve sustained economic growth.

In a nutshell, education as a crucial part of human capital plays a pivotal role to develop the nation. All the reviewed studies revealed a strong positive and long-run relationship between them and cointegrated each other. To support our argument that tertiary education has a crucial role to economy of Nepal, this study employed ARDL bounds test for cointegration then ECM.

Method

Data and its Sources

This study covered 30 annually observed time series data from 1998/90 to 2018/19 in Nepal. This study established the relationship between tertiary education and economic growth with the time series data sets consisting of observations for annual growth of real gross domestic product (*RGDP*) as a proxy for economic growth and gross enrollment rate at tertiary level (*GERT*) as a proxy for tertiary education of Nepal. Similarly, the gross-fixed capital formation as a percentage of *GDP* (*K*), labor force participation as a percentage of total population ages 15–plus (*L*), and annual change in consumer price index (*CPI*) was taken as a control variable. *RGDP* with 2000/01 based was extracted from the annual time series publication of Nepal Rastra Bank—Central Bank of Nepal—online portal and *GERT* from World Development Indicators. Missing *GERT* data was obtained with interpolation. *K* and *L* were also obtained from the World Development Indicators. *CPI* data is extracted from the economic survey of Nepal.

Unit Root Test

For estimating cointegration and casual relationship between the time series variables, the test of stationarity is a necessary condition to discover whether any spurious relationship exists between them. A stationary series can be defined as one with a constant mean, constant variance and constant autocovariances for each given lag (Brooks, 2008). Augmented Dickey Fuller (ADF) test were used to test the existence of unit root. The lag length on these extra terms was either determined by the Akaike Information Criterion (AIC)—or Schwartz Bayesian Criterion (SBC), or more useful by the lag length necessary to whiten the residuals (Asteriou & Hall, 2007). Phillips-Perron test was also employed to confirm the stationarity of the time series data sets. The ADF test for null hypothesis (H_o) of having unit root in time series began with the following equation;

$$\Delta y_t = \beta_0 + \beta_1 t + \rho y_{t-1} + \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + \ldots.. + \gamma_i \Delta y_{t-i} + \varepsilon_t$$

That is, $$\Delta y_t = \beta_0 + \beta_1 t + \rho y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i} + \varepsilon_t$$

where y_t is the variables of interest (*RGDP*, *GERT*, *K*, *L*, and *CPI*), ε_t is pure white noise error term, k is lag length. The optimal lag length was estimated by using AIC. For testing the stationarity of the presented time series, $\rho = 1$ is null hypothesis (H_o) for unit root against the alternative hypothesis (H_1) of $\rho < 1$. The acceptance of null hypothesis follows the presented time series is nonstationary and its rejection implies the presented time series is stationary. When the presented time series in levels are found to be stationary with mixed order of level and first difference, i.e., $I\{0\}$, $I\{1\}$ and none of stationary at $I\{2\}$ or more then in this case, it can be essential to ARDL bounds test for co-integration.

ARDL Bounds Test for Cointegration

In economic analysis, any two variables are cointegrated if they have a long-term equilibrium relationship between them. Thus, cointegration means that despite being individually nonstationary, a linear combination of two or more time series can be stationary (Gujarati, 2004). As Granger (1986) notes, "A test for cointegration can be thought of as a pre-test to avoid 'spurious regression' situations" (p. 226). In order to analyze the long-run relationship among variables of interest, order of integration must be defined. Hence, the ARDL bounds test for cointegration can be helpful to estimate the long-run relationship between education and economic growth when the time series variables have found to be mixed orders $I\{1\}$ and $I\{0\}$.

The unification of ARDL approach to cointegration was formulated by Pesaran, Shin, and Smith (2001). The ARDL bounds test to cointegration can be applied when the regressors are of $I\{0\}$ or $I\{1\}$, that is, mixed ordered none of the variables is of $I\{2\}$ or higher. This study had a general model:

$$RGPD_t = \alpha_0 + \alpha_1 GERT_t + \alpha_2 K_t + \alpha_3 L_t + \alpha_4 CPI_t + \varepsilon_t$$

The ARDL bounds test for conintegration approach proposed by Pesaran et al. (2001) is

$$\Delta RGPD_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta RGPD_{t-i} + \sum_{i=1}^{q} \alpha_{2i} \Delta K_{t-i} + \sum_{i=1}^{q} \alpha_{3i} \Delta L_{t-i} + \sum_{i=1}^{q} \alpha_{4i} \Delta CPI_{t-i} + \beta_1 RGPD_{t-i} + \beta_2 K_{t-i} + \beta_3 L_{t-i} + \beta_4 CPI_{t-i} + \varepsilon_t$$

In this equation Δ is the first difference operator, P and q are the optimum lag length for dependent and explanatory variables respectively, $\alpha_1 \ldots \alpha_7$ are short run dynamics of the model and $\beta_1 \ldots \beta_4$ are long run elasticity and ε_t is the error term. This study applied the bounds test for cointegration with the existence of cointegration against null hypothesis of no cointegration, that is, $H_0 : \beta_1 = \beta_2 \ldots = \beta_4 = 0$, and the alternative hypothesis (H_1) : at least one parameter not equal to zero, which is performed by Wald test using F-test. The decision criteria for the rejection of null when the value of F-statistic is higher than the upper bound, $I\{1\}$, critical value. Since there is a long-run relationship is exist, then the conditional ARDL-ECM model based on OLS was employed. The ARDL-ECM model specified the following equation:

$$\Delta RGPD_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta RGPD_{t-i} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta K_{t-i} + \sum_{i=1}^{q} \alpha_{3i}\, \Delta L_{t-i} + \sum_{i=1}^{q} \alpha_{4i}\, \Delta CPI_{t-i} + \xi ECT_{t-i} + \varepsilon_t$$

Where, ξ is the speed of adjustment parameter and ECT refers to the error correction term which implies that how much of the disequilibrium is being corrected.

Results and Discussion

Test of Stationarity: Unit Root Test

This study applied unit root test based on Augmented Dickey-Fuller Test (ADF) and Phillips-Perron Test (PP) to confirm the stationarity of time series of the variables of interest as the null hypothesis for unit root or non-stationary against the alternative hypothesis of the availability of stationary of time series in order to confirm that none of the variables is of $I\{2\}$ or higher order. Table 1 displays the results from different levels based on above criteria regarding order of integration.

Table 1

Augmented Dickey-Fuller Test (ADF) and Phillips-Perron Test (PP) Results

Variables	Augmented Dickey-Fuller Test			Phillips-Perron Test		
	Intercept	Trend and Intercept	Order of Integration	Intercept	Trend and Intercept	Order of Integration
RGDP	-5.603980 (0.0001)	-5.483480* (0.0006)**	*I* (0)	-5.667294 (0.0001)	-5.525879 (0.0005)	*I* (0)
GERT	-0.539911 (0.8691)	-2.869186 (0.1877)	*I*(1)	-0.783906 (0.8088)	-1.822003 (0.6679)	*I*(1)
ΔGERT	-3.891429 (0.0062)	-3.832461 (0.0296)		-4.006899 (0.0046)	-3.959436 (0.0225)	
K	0.597581 (0.9872)	-0.316228 (0.9861)	*I*(1)	0.13324 (0.9629)	-0.795007 (0.9546)	*I*(1)
ΔK	-4.515291 (0.0013)	-4.888634 (0.0027)		-4.649371 (0.0009)	-4.931644 (0.0024)	
L	-3.807528 (0.0083)		*I*(0)			
CPI	-4.570736 (0.0018)	-4.319015 (0.0135)	*I*(0)	-3.510157 (0.0149)	-3.698575 (0.0386)	*I*(0)

The use of non-stationary data can lead to spurious regressions. Analyzing whether a series is stationary is very essential, for the stationarity or otherwise of a series, can strongly influence its behaviour and properties (Brooks, 2008). The unit root test based of ADF and PP statistics are helpful to avoid the problem of nonstationary. The results of unit root test by ADF presented in Table 1 show that the RGDP, *L*, and *CPI* were of *I*(0) with constant as well and $I\{0\}$ with trend and intercept except *L* of them at 5% level of significance . Likewise, GERT and *K* had first difference significant of $I\{1\}$ at 5%, in accordance with ADF test results. The PP test results show that the order of integration RGDP and *CPI* was zero, that is, $I\{0\}$ with constant and also with trend and intercept. According to PP results, RGDP and K have $I\{1\}$ with constant and trend and intercept. However, *L* was not significant at any level with PP criteria. Table 1 shows that RDGP and CIP had $I\{0\}$ at level and order of integration of GERT, and *K* was one with both criteria. The both criteria showed that the variable interest, having mixed order of integration and none of the variables, was of $I\{2\}$ and more. Therefore, the appropriate model to cointegration was the ARDL model.

Bounds Tests for Cointegration

The ARDL model with *F*-statistic was used to determine the long-run relationship among variables of interest. As a null hypothesis (H_0), the ARDL bounds test was applied to examine whether there was a long-run relationship. There is no long-run relationship under *F*-statistic. Pesaran, Shin, and Smith (2001) proposed the lower bound, $I\{0\}$, and upper bound, $I\{1\}$, critical values of 3.65–4.66, 2.79–3.67, and 2.37–3.20 at 1%, 5%, and 10% significance levels, respectively for ARDL bounds test. This test was applied to determine the long-run relationship on the basis of *F*-statistic and $I\{0\}$ and $I\{0\}$. If *F*-statistic was lower than $I\{0\}$, we do not reject H_0; if *F*-statistic is higher than $I\{1\}$, we reject the H_0; and if the value of *F*-statistic lies between two bounds $I\{0\}$ and $I\{1\}$, we cannot conclude and hence model is not appropriate to further treatment. The bounds test for cointegration results are presented in Tables 2 with a maximum lag order of 2 for ARDL vector error correction model.

Table 2

Results from ARDL Long Run form and Bound Test

Dependent variables	Lags	F-statistic	Decision
F_{RGDP} (RGDP|GERT, CAP, LAB, CPI)	1	9.276768	Cointegration
F_{GERT} (GERT|CAP, LAB, RGDP, CPI)	1	4.085334	Cointegration
F_{CAP} (CAP|GERT, LAB, RGDP, CPI)	2	5.199578	Cointegration
F_{LAB} (LAP|GERT, CAP, RGDP, CPI)	1	17.19398	Cointegration
F_{CPI} (CPI|GERT, LAB, RGDP, CAP)	2	6.199437	Cointegration
	1%	*5%*	*10%*
Critical Value $I\{0\}$	3.65	2.79	2.37
Critical Value $I\{1\}$	4.66	3.67	3.20

The result of ARDL bounds test *F*-statistic of all the cases were higher than $I\{0\}$ at 5 % level, implying a long run relationship amongst the all variables of interest whether one of them, keeping as a dependent variable (normalized) simultaneously. This also implies that the null hypotheses of no cointegration among the variables in each of all cases had no evidence to accept. So, there were cointegration among the variables in each of all cases. It is an evident that there was cointegration between GERT and RGDP as well as positive long-run relationship. It is also revealed that the GERT was also influenced by the *L* and *K*. It is evident that we can run the error correction model for this ARDL model.

Error Correction Model (ECM)

The cointegration among the variables of interest (*RGDP*, *GERT*, *K*, *L*, and *CPI*) confirmed the applicability of error correction model in ARDL approach. Table 3 presents the long run bounds test results.

Table 3

Results of Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-51.72378	96.44808	-0.536286	0.5980
$RGDP_{t-1}$*	-1.313315	0.199536	-6.581855	0.0000
$GERT_{t-1}$	0.052282	0.320353	0.163201	0.8721
KT**	0.218392	0.098928	2.207598	0.0398
LT**	0.595218	1.124844	0.529156	0.6028
CPI_{t-1}	0.209839	0.166714	1.258677	0.2234
$\Delta GERT$	0.781043	0.375695	2.078930	0.0514
ΔCPI	-0.021074	0.104187	-0.202268	0.8419
ΔCPI_{t-1}	-0.236102	0.103779	-2.275036	0.0347

* p-value incompatible with t-Bounds distribution.

Table 3 shows the conditional error correction regression where long run coefficient of $GERT_{t-1}$ had positive and significant relationship with the dependent variable *RGDP* at 5 % level, implying that *RGDP* increased by 5.23 % when 1 % increase in *GERT*. Table 4 shows the error correlation model estimations.

Table 4

Error Correction Model Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-51.72378	6.894711	-7.501951	0.0000
$\Delta GERT$	0.781043	0.258165	3.025369	0.0070
ΔCPI	-0.021074	0.080136	-0.262974	0.7954
ΔCPI_{t-1}	-0.236102	0.077452	-3.048365	0.0066
(CointEq)$_{t-1}$* (=ECT_{t-1})	-1.313315	0.175266	-7.493254	0.0000
R-squared	0.745402	Mean dependent var		0.022643
Adjusted R-squared	0.701125	S.D. dependent var		2.699050
S.E. of regression	1.475557	Akaike info criterion		3.776381
Sum squared resid	50.07719	Schwarz criterion		4.014275
Log likelihood	-47.86933	Hannan-Quinn criter.		3.849107
F-statistic	16.83466	Durbin-Watson stat		2.353283
Prob(F-statistic)	0.000001			

* p-value incompatible with t-Bounds distribution.

Table 4 shows the negative value of ECT_{t-1}. The positive value of error correction term (ECT_{t-1}) or coeintegration equation (t–1) indicated a divergence, and negative value indicated a convergence and this values showed that the extent to which any disequilibrium in the previous year was being adjusted in current year. In our model, ECT_{t-1} was negative (–1.313315) and statistically significant at 1 and 5 % significance level (0.000 < 0.01 or 0.000 < 0.05) along with a high coefficient (-1.313315), which revealed that, in long-run, disequilibrium could be adjusted with higher speed, having any prior-year shock in the explanatory variables (*GRET* and *CPI*). It strengthened the presence of long run relationship among *GDP*, *GERT*, and *CPI*. Here the speed of adjustment from previous year's disequilibrium in *RGDP* added to current year's equilibrium was only 131.33 %.

Diagnostic and Stability Test

The ARDL model was applied when the results were subjected to numerous econometric tests, such as heteroscedasticity, serial correlation, normality and stability (Green, 2008). Some econometric tools employed in this model as a diagnostic and stability test of the dataset of variables of interest. Table 5 presents the estimated diagnostic test results.

Table 5

Results of Diagnostic Tests

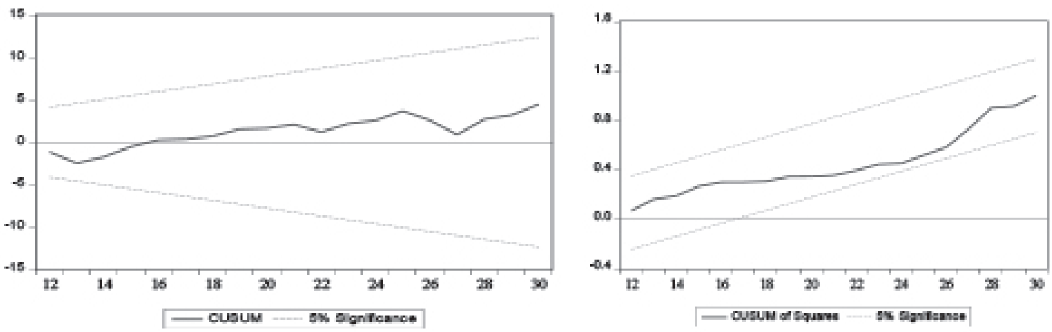
Diagnostic Tests	χ^2 statistic	P-Value	Decision
Breusch-Godfrey Serial Correlation LM Test	3.804485	0.0511 (not significant)	No serial correlation
Heteroskedasticity Test: Breusch-Pagan-Godfrey	4.353457	0.8239 (not significant)	No heteroskedasticity, autocorrelation
Jarque-Bera Test	0.194193	0.907468 (not significant)	Residuals are normally distributed
Ramsey RESET Test (Log likelihood ratio)	-47.05622	0.135364 (not significant)	Correct specification

The diagnostic tests against serial correlation (Breusch-Godfrey test), heteroscedasticity (Breusch-Pagan-Godfrey), and normality of errors (Jarque-Bera test) showed insignificance at 5% level, revealing no heteroscedasticity, no autocorrelation; and normally distributed residuals. The Ramsey RESET test also suggests that the model was well specified. All the results of these tests are shown in Table 5. These diagnostic tests results suggest that the ARDL mode we ran was well specified and had econometric properties.

Once the ECM model was estimated, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests were introduced to evaluate the parameter stability (Pesaran and Pesaran (1997). The result of the CUSUM and CUSUMQ, according with ARDL error correction model, is illustrated by the following figures, respectively.

Figure 1

CUSUM Test and CUSUMSQ Test



The Figure 1 shows the results of the CUSUM and CUSUMSQ stability test for the model. In Figure 1, the plot of CUSUM and CUSUMSQ lied within the 5

% critical bound, then we failed to reject the null hypothesis of the stability of the parameters, which revealed that the ARDL model we ran was robust and stable over the study period 1989/90 to 2018/19 in short-run and long-run. Thus, it confirmed that the ARDL model were structurally stable.

Conclusion

In order to know the relationship between tertiary education (proxied as gross enrolment rate at tertiary level) and economic growth (growth rate of real *GDP*) in Nepal, we employed ARDL bounds test for cointegration and ECM with the time series over the period from 1989/09 to 2018/19. The study focused on the cointegration between tertiary education and economic growth, determined by the presence of labor force (proxied as labour force participation rate of age 15 plus), capital (gross fixed capital formation), and *CPI*. This study revealed cointegration between tertiary education and economic growth of Nepal—an evidence of the existence of long-run relationship. It indicates that when increase in enrollment in tertiary schooling, it helps to increase economic growth in long-run. This study also had an evidence of a short-run relationship between education and economic growth. In the other hand, cointegration between fixed capital formation and human capital with tertiary education revealed that tertiary education also seems to have significant effect on these variables. The highly significant *L* on RGDP than *K* implied that there appears to be positive and significant effect of human capital on economic growth than fixed capital. The negative and significant ECT_{1-t} strengthens the presence of long-run relationship among *GDP* and *GERT*. Thus, tertiary education covers various technical and professional attainment—hence as an essential ingredient of human capital, which tends to play a crucial role to economic growth and development of Nepal. Based on the results of this study, it is suggested that the government must be focused on the policy of overall betterment of tertiary education.

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