The Nexus between Higher Education and Economic Growth: An Empirical Investigation for Pakistan

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Abstract

The study investigates the role of higher education in economic growth for Pakistan between 1972 and 2005 using the application of Johansen Cointegration and Toda & Yamamoto (1995) Causality approach in Vector Autoregressive (VAR) framework. It examines whether higher education affect long run economic growth in Pakistan. The empirical analysis reveals that there is a long run relationship between economic growth and higher education, which suggests that these variables are necessary for each other. The empirical results of causality test indicate that there exists a unidirectional causality running from economic growth to higher education and no other direction of causality found between these variables.

Keywords: Pakistan, Higher Education, Economic Growth, Cointegration and Causality.

1. Introduction

In an era when intellectual capital is increasingly prized, both for individuals and nations, higher education has become vitally important. Higher education can produce critical thinkers and innovators, as well as healthy, informed and engaged citizens. Higher education maintains social mobility and a high standard of living. Higher education can combat current public policy challenges including democratic renewal and health care. Moreover, world's higher education institutions and universities have driven research that has battled previously incurable diseases, and provided the facilities for innovative business ideas and political theories that have shaped the fortunes of cities, regions and even nations. So, Pakistan's high economic growth and access to new technologies is also associated with higher education.

The government's commitment to education was declared at the National Educational Conference (NEC) in 1947. It was the first step towards defining education policies and goals in Pakistan. "There have been eight national education polices during the last 58 years of Pakistan and a number of commissions and committees have been set up by different governments attempting to make various changes in Pakistan's educational scenario" [Khalid and Fayyaz (2006)]. However, the history of education policymaking and planning shows that each round of policymaking repeats the same pattern, the importance of education is iterated, the failure of past efforts is lamented, the main issues in education reform are highlighted and new plans are proposed to meet new targets. Yet the targets have remained elusive up to now.

The education sector in Pakistan has suffered from persistent and severe under investment by the government throughout the last five decades. Public spending on education presently stands at 1.8% of GDP as against 4% of GDP set forth by UNESCO for education. According to the UNDP, Pakistan is one of the 12 countries in the world, which spends less than 2 % of GDP on education[1]. Over the past years, non-availability of sufficient public funds has been creating bottlenecks in success of education programs.

The education spending in recent years increased significantly specially on higher education. Despite the significant increases, government spending on higher education was still very low in 2004/05. The spending on higher education as a share of Gross Domestic Product GDP, total Government of Pakistan (GoP) spending and total education spending over the 2001/02-2004/05 are given in Table 1.

[1] Cited from "Social Policy and Development in Pakistan (2003). The State of Education, Annual Review 2002-2003, Social Policy and Development Centre, Karachi, Pakistan, p.4".

Table 1: Higher Education Spending Relative to GDP, GoP Budget and Total Education Spending for the Fiscal Years 2001/02-2004/05

Indicator	2001/02	2002/03	2003/04	2004/05
Higher Education Spending/GDP (%)	0.1%	0.2%	0.2%	0.3%
Higher Education Spending/GoP Budget (%)	0.5%	0.9%	1.1%	1.6%
Higher Education Spending/Total Education Spending (%)	6.9%	10.7%	11.2%	14.4%

Source: The World Bank (2006), Higher Education Policy Note, p.13

The main objective of the study is to find out the long run relationship along with the direction of causality between higher education and economic growth using the application of Johansen Cointegration and Toda & Yamamoto Causality approach. The rest of the study is organized as: Section 2 reviews literature on the relationship between education and economic growth. Section 3 formulates the econometric model and also explains data sources. Section 4 discusses the methodology for analysis as well as the time series properties of the variables. Section 5 reports the empirical results based on cointegration and the causality tests. Section 6 presents conclusions and recommendations.

2. Literature Review

The early work of Solow (1956, 1957) showed that economic growth could not only be explained by capital and labor increase. His aim was to determine the contributions of the factors of production (capital and labor) and the increase in technical progress to the growth rate as a whole. Later on, the endogenous growth model was developed by Lucas (1988), which considered human capital as one of the factor of production and education as a means of human capital accumulation. According to Lucas (1988), education was a vehicle for human capital accumulation and was treated as a factor of production besides labor and physical capital. This implies that progress in the educational attainments of the labor force has a positive impact on productivity that leads to better economic performance at aggregate level.

It is commonly considered that the main objective of education is to develop human capital. However, education alone does not necessarily develop this type of capital. It is also developed by other social activities and actions that can contribute to the accumulation process. According to Fogel (1994), in addition to general education (schooling and training), better health, physical strength, nutrition and occupational training contribute to the level of accumulated human capital.

A great deal of literature on growth stemming from the work of Barro (1991, 2001) has paid attention on some measure of human capital as a determinant of economic growth. Barro (1991) verified that in the period 1960–1985 the growth rate in a sample of 98 countries depends positively on the initial level of human capital measured by schooling rates and negatively on the initial level of per capita GNP. Mankiw *et al* (1992) extended Solow's model by introducing the accumulation of human capital measured by education levels and found that contribution of human capital is significant.

Barro and Lee (1993) have studied the rate of schooling success in the adult population at various levels (primary education, secondary education, higher education) from 1960 to 1985 in 129 countries and concluded that levels of education have significant explanatory capacity. Education has direct positive relationship with the growth rate of GNP. In contrast, Benhabib and Spiegel (1994) maintain that the growth rate of human capital measured by the number of years of education of the working population does not significantly explain the growth rates of per capita output. However, human capital levels play a substantial role as determinants of increase in per capita income.

Bils and Klenow (2000) argued that in any case, a significant positive correlation between education and output growth does not imply that education affects growth. Instead, both education and output growth could be driven by an omitted variable, total-factor-productivity growth for example. Bils and Klenow (2000) are not alone. Pritchett (2001) also showed that variation in the change in average schooling plays little role in explaining cross-country variation in growth rates. In contrast Gemmell (1996) found both the levels of human capital and their growth rates to be important in explaining growth. Benhabib and Spiegel (1994) investigated whether education influences rates of technological progress and Temple (1999) showed that their inability to produce a significant coefficient on human capital may be due to the influence of outliers. Temple (2001) revisited the data and for two of his empirical investigations concluded that it is hard to reject the Pritchett (2001)'s view that large investments in education have yielded a very small pay-off in developing countries.

On the other hand, Gylfason and Zoega (2003) used endogenous growth model for the data of 87 countries around the world and showed that, across countries, three different measures of education (a) gross secondary-school enrolment, (b) public expenditure on education relative to national income and (c) expected years of schooling for girls, varies directly with economic growth and concluded that education seems likely to encourage economic growth not only by increasing and improving human capital but also physical capital and social capital.

Gutema and Mekonnen (2004) with particular reference to the case of sub-Saharan Africa, following the endogenous growth model developed by Lucas (1988) that considers human capital as one factor of production and education as a means of human capital accumulation also found that education has a positive influence on the economic growth rate.

Most of the studies were carried out to see the impact of basic education as a human capital in economic growth. McMahon (1987), Horii *et al* (2007) Voon (2002) investigated the relationship between higher education and economic growth. McMahan (1987) found that higher education has a positive effect on income growth, but with a long lag – about seven and half years. Voon (2002) argued that the higher the level of education due to high investment, the stronger the growth impact of education. While Horii *et al* (2007) showed that higher education raises individual earnings, but its contribution to economic growth in the long run is less clear.

3. Econometric Model, Data Sources and Methodology

3.1 Specification of Econometric Model

Empirical studies of economic growth begin with the neoclassical model, originally proposed by Solow (1956) and extended by Mankiw, Romer, and Weil (1992) to include human capital. This model appears in the general form as:

$$Y_t = A_t K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha-\beta} e_{1t}\ ; \quad t = 1, 2, 3\ldots \qquad (1)$$

Where Y_t is aggregate production of the economy, A_t is total factor productivity, K_t is real capital stock, L_t is employed labour force, H_t is higher education enrolments at time t and e_{1t} is the error term. Taking natural logs (*Ln*) on both sides of equation (1) gives an estimable linear function:

$$Ln\, Y_t = Ln\, A_t + \alpha LnK_t + \beta LnH_t + \gamma LnL_t + e_{2t}\ ; \qquad t = 1, 2, 3\ldots \qquad (2)$$

Where α, β, γ $(1-\alpha-\beta)$ are the elasticities of production with respect to capital, human capital (higher education) and labor respectively and $Ln\, A_t$ is a constant parameter, and e_{2t} is the error term, which reflects the influence of all other factors.

3.2 Data Sources

The data for the study are time series data covering the time period 1972-2005. They were gathered from the Economic Survey of Pakistan (various issues). The variable K_t, represents gross fixed capital formation (proxy variable for physical capital). The output, Y_t, is aggregate out put and measured by real GDP (proxy variable for economic growth). Gross fixed capital formation and real GDP are evaluated in Pakistani rupees at constant year 2000 prices. The labor force, L_t, represents the total number of employed people each year. H_t is higher education and represents number of enrolled students at university level.

3.3 Econometric Methodology

To find out the role of higher education on economic growth, this study employs time series econometrics, such as cointegration and causality. These techniques are widely used in a Vector Autoregressive (VAR) framework, this study also uses these techniques in a VAR modeling framework for the analysis of data. Granger (1969) developed a test to check the causality between variables. Granger and Newbold (1974) pointed out that there is a possibility of spurious causality, to avoid it, all series under investigation need to be stationary. Granger (1988) asserts that, standard tests for causality are valid only if there exits a cointegrating relationship. That is, to check the cointegrating properties of the variables under consideration is a necessary precondition for causality testing.

3.3.1 Unit Root Test

The number of unit roots in each variable is determined by performing the Augmented Dickey-Fuller (ADF) test. The study uses following two types of ADF regressions:

$$\Delta X = \alpha_0 + \beta X_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta X_{t-1} + \varepsilon_t\ ; \text{(with an intercept)} \qquad (3)$$

$$\Delta X = \alpha_0 + \alpha_1 t + \beta X_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta X_{t-1} + \varepsilon_t$$; (with an intercept and a time trend) (4)

where $\Delta X_t = X_t - X_{t-1}$ p = Number of lags in the dependent variable ε_t = Stochastic error term.

The stationarity of the variable can be testd by using the following hypothesis:

H_0: *$\beta=0$; (X_t is Non-Stationary)*

H_a: *$\beta<0$; (X_t is Stationary)*

Reject the null hypothesis if the test statistic is less than the critical value in real terms. The optimum lag length in the ADF regression insures the residuals are not to be serially correlated and should imitate a white noise process.

3.3.2 Cointegration

Having tested the stationarity of each time series, and confirmed that each series have the same order of homogeneity (*d*), the next step is to search for cointegration between X_t and Y_t. In this step, this study would investigate whether there is a long run relationship between the stochastic trends of X_t and Y_t. In order to find out any type of causality between X_t and *Yt,* they must be cointegrated in the Granger sense. This precondition can be confirmed by using either the Engle-Granger two-step cointegration procedure or Johansen-Juselius rank-based cointegration test. The Engle-Granger procedure is valid for two variables. In the case of three or more variables, Johansen (1988), and Johansen and Juselius (1990) have introduced an appropriate method for cointegration.

Johansen (1988), and Johansen and Juselius (1990) have developed a maximum likelihood testing procedure on the number of cointegrating vectors, which also includes testing procedures for linear restrictions on the cointegrating parameters, for any set of variables. Two test statistics that are used to identify the number of cointegrating vectors, namely the trace test statistic and the maximum eigen-value test statistic. The trace statistic tests the null hypothesis that the number of distinct cointegrating relationships is less than or equal to '*r*' against the alternative hypothesis of more than '*r*' cointegrating relationships, and is defined as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{p} \ln(1-\hat{\lambda}_j) \quad (5)$$

where λ_j = The eigen-values ***T*** **=** Total number of observations. The maximum likelihood ratio or put another way, the maximum eigen-value statistic, for testing the null hypothesis of at most '*r*' cointegrating vectors against the alternative hypothesis of '*r+1*' cointegrating vectors, is given by:

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1}) \quad (6)$$

Johansen (1988) argues that, λ_{trace} and λ_{max} statistics have non-standard distributions under the null hypothesis, and provides approximate critical values for the statistic, generated by Monte Carlo methods.

3.3.3 Granger Causality Based on Toda-Yamamoto Procedure

The usual Granger (1969) causality test for inferring leads in spurious regression results, and the *F*-test is not valid unless the variables in levels are cointegrated. New developments in econometrics offer the error correction model [due to Engle and Granger (1987)] and the Vector Autoregressive Error-Correction Model [due to Johansen and Jesulius (1990)] as alternatives for the testing of non-causality between economic time series. Toda and Yamamoto (1995) showed that these tests are cumbersome and sensitive to the values of the nuisance parameters in finite samples and therefore their results are unreliable.

A new method has proposed by Toda and Yamamoto (1995), for causal inference based on augmented level VAR with integrated and cointegrated processes. The advantage of using this procedure is that it is not necessary to pretest the variables for the integration and cointegration properties and therefore avoids the possible pretest biases.

Toda and Yamamoto (1995) procedure uses a Modified Wald (MWALD) test for restrictions on the parameters of the VAR (k) model. This test has an asymptotic chi-squared distribution with k degrees of freedom in the limit when a VAR [k+d(max)] is estimated (where k is the lag order of VAR and d(max) is the maximal order of integration for the series in the system).

Two steps are involved with implementing the procedure. The first step includes determination of the lag length (k) and the maximum order of integration (d) of the variables in the system. Schwartz Information Criterion (SIC) Criterion is used to determine the appropriate lag structure of the VAR. Given VAR (k) selected, and the order of integration d(max) is determined, a levels VAR can then be estimated with a total of k+d(max) lags. The second step is to apply standard Wald tests to the first k VAR coefficient matrix (but not all lagged coefficients) to make Granger causal inference.

In order to test for Toda and Yamamoto (1995) based Granger causality between economic growth and higher education the study estimates the following VAR (*k*+*d*) model, to avoid functional biasedness and following Solow (1956) and Romer *et al*. (1992), the study also includes important input factors of production (K_t and L_t) in VAR (*k*+*d*):

$$\begin{bmatrix} LnY_t \\ LnH_t \\ LnK_t \\ LnL_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} + \sum_{i=1}^{k+d} \begin{bmatrix} \beta_{1i} & \delta_{1i} & \phi_{1i} & \theta_{1i} \\ \beta_{2i} & \delta_{2i} & \phi_{2i} & \theta_{1i} \\ \beta_{3i} & \delta_{3i} & \phi_{3i} & \theta_{1i} \\ \beta_{4i} & \delta_{4i} & \phi_{4i} & \theta_{1i} \end{bmatrix} \begin{bmatrix} LnY_{t-i} \\ LnH_{t-i} \\ LnK_{t-i} \\ LnL_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (7)$$

where *t* is the time subscript. LnY_t, LnH_t, LnK_t, and LnL_t are economic growth, higher education, physical capital and labor force respectively in logarithmic form.

k = Optimal lag order of VAR

d = Maximal order of integration of the series in the system

α's are the intercepts. β's, δ's, ϕ's and θ's are the coefficients of economic growth, higher education, physical capital and labor force respectively.

$\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}$ and ε_{4t} are error terms that are assumed to be white noise.

Usual Wald tests are then applied to the first *k* coefficient matrices using the standard χ^2- statistics. The main hypothesis can be drawn as Y_t "Granger-causes" H_t if $\delta_{1i} \neq 0$, K_t if $\phi_{1i} \neq 0$, L_t if $\theta_{1i} \neq 0$. Similarly, other hypothesis can be drawn for unidirectional and bidirectional causality among rest of the under investigating variables.

4. Empirical Results

Before testing for cointegration, the unit root test is used in order to investigate the stationarity properties of data and all variables are found stationary at first difference. After investigating the order of integration study proceed for cointegration and Granger causality test. For the investigation of dynamic behavior of all variables impulse response function and variance decomposition is also carried out.

4.1 Order of Integration

ADF unit root test is employed to test for the stationarity of Y_t, K_t, L_t and H_t, at level and then first difference of each series. The results of the ADF test at level and first difference are reported in Table 2, by taking into consideration of trend variable and without trend variable in the regression. Based on Table 2 at level, the t-statistics for all series from ADF test are statistically insignificant to reject the null hypothesis of non-stationary at 5% significance level. This indicates that these series are non-stationary at their level form.

Table 2: Dickey-Fuller/Augmented Dickey-Fuller (ADF) Test for Unit Root

	Level		**1st Difference**	
Variables	**Without Trend (k)**	**Trend & Intercept (k)**	**Without Trend (k)**	**Trend & Intercept (k)**
Ln $\boldsymbol{Y_t}$	-1.724(2)	-2.752(2)	-4.620*(1)	-4.830*(1)
Ln $\boldsymbol{H_t}$	-0.356(2)	-1.846(2)	-4.234*(1)	-4.114*(1)
Ln $\boldsymbol{K_t}$	-2.384 (2)	-2.869 (0)	-4.166* (1)	-4.742* (1)
Ln $\boldsymbol{L_t}$	-0.802 (0)	-2.727 (0)	-5.823* (0)	-5.753* (0)

Note: The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of null hypothesis for ADF test is based on the MacKinnon critical values and numbers in parentheses indicate number of optimum lags (k) based on Schwarz Information Criterion (SIC).

* Indicates the rejection of the null hypothesis of non-stationary at 5% significance level.

When the ADF test is conducted at first difference of each variable, the null hypothesis of non-stationary is easily rejected at 5% significance level as shown in Table 2. This is consistent with some previous studies[1] which demonstrated that most of the macroeconomics and financial series are expected to contain unit root and thus integrated of order one, *I(1)*. Since the variables are integrated of same order *I(1)*, so, multivariate cointegration test for long run analysis could be conducted.

4.2 Cointegration

The results of the Johansen cointegration test for higher education and economic growth by using both λ_{trace} and λ_{max} test statistics are given in Table 3 and Table 4 respectively. The test strategy begins with r = 0 in Table 3 and Table 4, the null hypothesis r = 0 (no cointegration) was rejected in favour of r = 1, but the null hypotheses of r $\leq$ 1, r $\leq$ 2 and r $\leq$ 3 cannot be rejected in favor of the alternative hypotheses at 5% level of significance, indicating the presence of a unique cointegrating vector between Y_t, K_t, L_t and H_t. The results of cointegration test suggest that higher education and economic growth are bedfellows in the long run.

Table 3: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

H_0	H_a	λ_{max} test	λ_{max} (0.95)	Prob.***
r = 0*	r = 1	27.734*	27.584	0.0493
r $\leq$ 1	r = 2	20.887	21.132	0.0541
r $\leq$ 2	r = 3	5.820	14.265	0.6364
r $\leq$ 3	r = 4	3.174	3.841	0.0748

Notes: Max-eigenvalue test indicates 1 cointegrating equation at the 5% level.

* Denotes rejection of the hypothesis at the 5% level.

***MacKinnon-Haug-Michelis (1999) p-values.

Table 4: Unrestricted Cointegration Rank Test (Trace)

H_0	Ha	Trace test	Trace (0.95)	Prob.***
r = 0*	r $\geq$ 1	57.463*	47.856	0.0049
r $\leq$ 1	r $\geq$ 2	29.580*	29.797	0.0649
r $\leq$ 2	r $\geq$ 3	8.994	15.495	0.3659
r $\leq$ 3	r $\geq$ 4	3.174	3.841	0.0748

Notes: Trace test indicates 1 cointegrating equation at the 5% level.

* Denotes rejection of the hypothesis at the 5% level.

***MacKinnon-Haug-Michelis (1999) p-values.

$$LnY_t = -1.9585 + 3.1423LnL_t + 1.390LnK_t + 0.5328H_t \quad (8)$$

t-statisitcs (2.3056) (7.9043) (1.4776)

The normalized cointegrated vector is reported in equation (8). The estimates represent the long run elasticities of output with respect to labor, capital and higher education. This vector is a stable equilibrium relationship to which the variables have a tendency to return in the long run. The positive coefficients of labor, capital and higher education indicate that these variables move in same direction in long run. While insignificant coefficient

[1] See for example [Ahmad. M.H, S.Alam and M.S.Butt(2004), Akbar .M and Z. F.Naqvi (2000), Ahmad, Q, M; M.S.Butt and S.Alam (2000)]

of higher education indicates that current year's out put of higher education is not important for enhancing economic growth. The long run empirical results are consistent with the study of McMahan (1987) who found that higher education has a positive effect on income growth, but in a long run.

4.3 Causality based on Toda-Yamamoto Methodology

The results of Granger causality test based on Toda and Yamamoto (1995) are reported in Table 5. The optimum lag length of VAR is k=2 based on SIC criterion. However, all variables are stationary at first difference. This means that d_{max} = 1. So, we estimate a system of VAR at levels with a total of $d_{max} + k = 1 + 2 = 3$ lags. The results in table 5 suggest that causality is running from labor and capital to economic growth, economic growth to labor and economic growth to higher education. While there is no evidence of bi-directional causality except between labor and economic growth.

This indicates that there is unidirectional causality running from economic growth to higher education while higher education does not cause economic growth, because the proportion of highly educated labor in the total population of Pakistan has been too low. The main reason of low proportion of highly educated people is that the low enrolment and high dropout ratio at basic level of education in Pakistan and majority of the population belong to poor families and after basic education they support their families which discourage enrolment in higher education. And many of the existing highly educated people go abroad either for further higher education or in search of better job opportunities and most of them do not return and cause a large public loss.

Table 5: Granger causality test results between LnY_t, LnL_t, LnH_t and LnX_t based on the Toda-Yamamoto procedure

Dependent Variable	Modified Wald-Statistics			
	LnY_t	LnL_t	LnK_t	LnH_t
LnY_t	---	9.261* (0.0454)	10.1658* (0.01612)	4.09472 (0.2514)
LnL_t	13.3605* (0.0039)	---	6.5164 (0.089)	5.5043 (0.13233)
LnK_t	0.7605 (0.8589)	4.8636 (0.1821)	---	5.7984 (0.1218)
LnH_t	7.0876** (0.0692)	0.6292 (0.8897)	2.1940 (0.5331)	---

Notes: The $k+d_{max}$ = 2+1=3rd order level VAR was estimated, the order of integration is d_{max} =1. Lag length selection was based on SIC criterion. Values in parentheses are p-values.

and ** indicates level of significance at 5% and 10% respectively.

5. Summary and Conclusions

The cointegration modeling techniques used in the study has revealed that there is a long run relationship between investigated variables (output, capital, labor and higher education). Overall, the empirical results suggest that the higher education and economic growth have long run contemporaneous relationship or equilibrium. Toda and Yamamoto causality test has indicated that there is a unidirectional causality running from economic growth to higher education but higher education does not cause economic growth as the higher education effects economic growth after a gap of time.

The gross enrolment ration in higher education institutions of Pakistan is 3% as compare with India (11%), Bangladesh (7%) and Nepal (6%). Sound policies need to be adopted for increasing and improving the higher education and thereby economic growth. Since the proportion of highly educated people in the total population of Pakistan is too low, so, there is a need to increase the proportion of highly educated labor in the overall population. For this purpose in the higher education institutions, government should give more emphasis to finance and built the infrastructure according to the need of growing population. The higher education in many universities and institutions of Pakistan is based on self-finance. To increase the enrolment in the higher education, a highly subsidized education system needs to be introduced. The highly incentive based programs in higher education should be introduced. Moreover, to stop the brain drain the emphasis should be given to absorb unemployed highly educated people in the public and private sectors at competitive service and pay structure.

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