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Causality between Education and Economic Growth in Bangladesh - An Error Correction Modeling Approach

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Abstract

The paper examines the causality between revenue expenditure on education and economic growth, development expenditure on education and economic growth, and total expenditure on education and economic growth in Bangladesh during the period 1974 to 2008. We apply cointegration and error correction modeling approach. Results show that there is bi-directional causality between educational expenditure and economic growth in Bangladesh. This means that revenue, development and total expenditures on education cause economic growth and economic growth causes them.

Keywords: *Education, Economic Growth and ECM.*

1. Introduction

Since the era of Plato, the role of education and education-economic growth relationship are the focus of public debate. A considerable portion of the country's wealth is invested in education. This investment in education leads to human capital formation, comparable to physical capital and social capital, that contribute to economic growth significantly (Dickens, 2006; Loening, 2004; Gylfason and Zoega, 2003; Barro, 2001). Further, investment in education

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contributes to the formation of skilled manpower that geared to the needs of growth, both for accelerating economic growth and for increasing the quality of the society (Yogish, 2006).

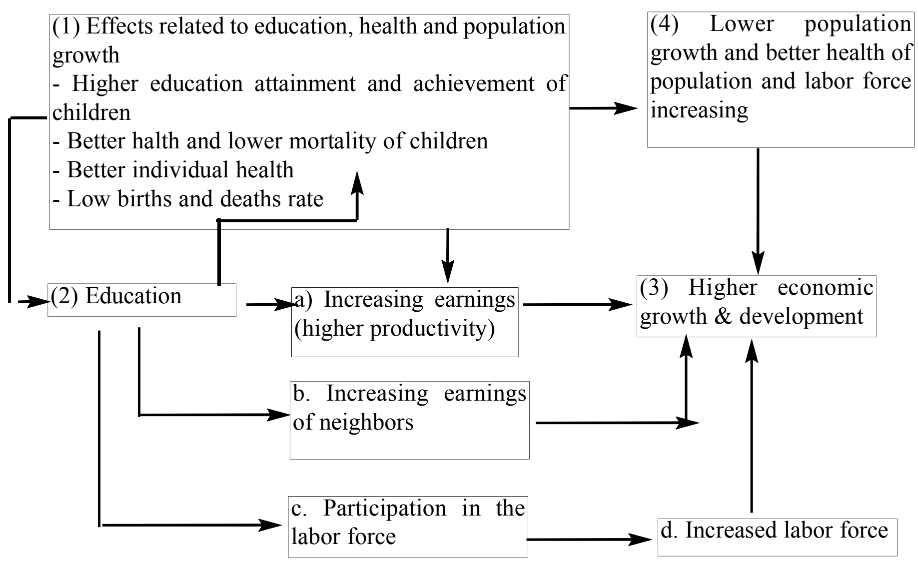
Improving health, reducing fertility and bringing political and social stability can be ensured through education that can contribute to economic growth. The significance of an educational system to any labor market lies in its ability to produce a literate, disciplined, flexible labor force via high quality education. Consequently, with economic growth the application of new technology in production results in an increase in the demand for workers and better education (Pradhan, 2009). The pioneer work of Lucas (1988) reveal that the growth rate of human capital is dependent on the amount of time allocated by individuals to acquire skills.

In literature on education and economic growth relationship, the first contribution was made by Adam Smith, followed by Marshall, Schultz, Bowman and others (Tilak, 2005). Overtime, various theories and models relating education and economic growth emerged (Lucas, 1988; Romer, 1990; Rebelo, 1991, Grossman-Helpman, 1991; Francis and Iyare, 2006). These studies mostly deal with the role of human capital accumulation in economic growth and endogenously generated economic growth (Chakraborty, 2005). Most of these researches observed that an alternative engine of economic growth to technological change is human capital; however, the country needs to invest more on education to get quality human capital. Both at the micro and macro levels, an investment in education is very beneficial in the society (Figure 1) and this investment affects the system directly and indirectly (Dahlin, 2005). While the increase in wage is a direct effect, the increasing externalities associated to education is an indirect effect (Heckman and Klenow, 1997).

Educational expenditure in Bangladesh has been increasing since the independence. In 1973, total educational expenditure was Tk. 73 core, which rose to tk. 1330 core, Tk. 4273 core and Tk. 20470 core in 1990, 2000 and 2008, respectively. Gross domestic product (GDP) has also been rising since independence. In 1974, GDP was Tk. 7575 core, which rose to Tk. 73757 core, Tk. 237086 core and Tk. 541919 core in 1990, 2000 and 2008, respectively. It is evident that both GDP and educational expenditure have been rising over the years. Therefore, it is worthwhile to assess whether educational expenditure causes GDP to grow or GDP causes educational expenditure to grow or they cause each other to grow. This paper aims to assess the long-run causal relationship between revenue expenditure on education and economic growth, development expenditure on education and economic growth, and total education expenditure and economic growth of Bangladesh and provide some policy suggestions.

The rest of the paper is organized as follows. Section 2 describes data and methodology, Section 3 provides empirical methodology, Section 4 details empirical result and Section 5 concludes the paper.

Figure 1: Economic Effect of Education on Economic Growth



Source: Michaelowa (2000)

2. Data Description

We use secondary data for the period from 1974 to 2008. We use revenue expenditure on education, development expenditure on education and total expenditure on education as proxy of education and GDP as proxy of economic growth. These data are collected from various issues of Bangladesh Economic Review, Bangladesh Statistical Year Book and publications of Ministry of Education. Figures 2 and 3 provide graphical representations of GDP and revenue, growth and total expenditures on education. These show that both GDP, components of expenditures on education have upward trends with some fluctuations. This indicates that the series suffer from non-stationarity problem. In other words, the series suffer from short-run instability.

Figure 2 : Gross Domestic Product

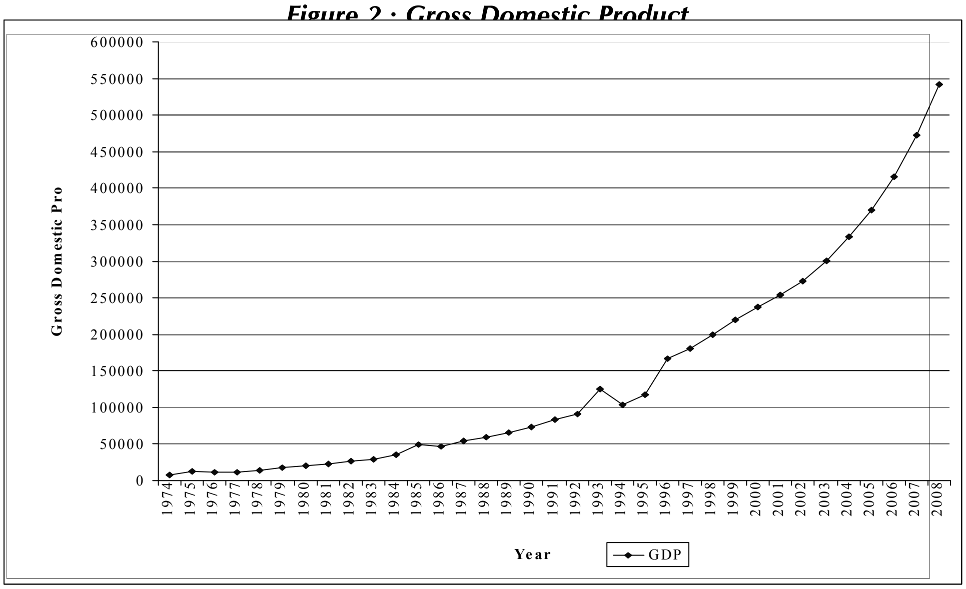
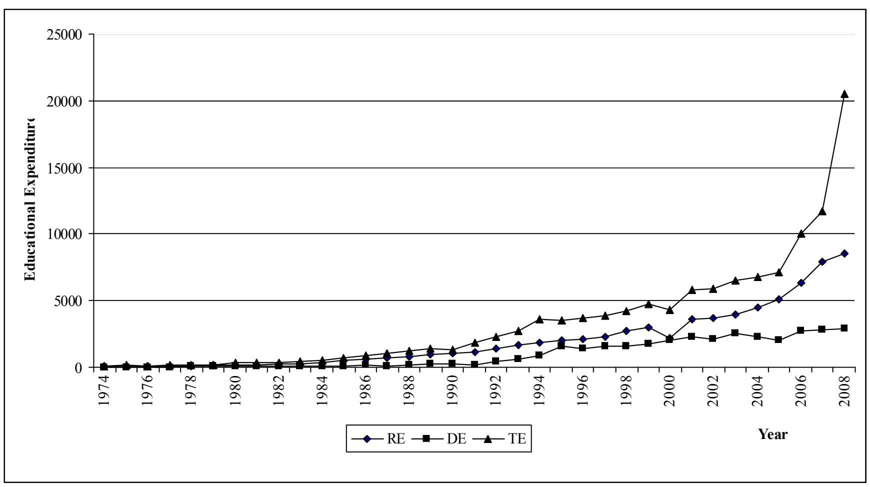


Figure 3: Revenue, Development and Total Educational Expenditures



3. Empirical Econometric Methodology

Empirical methodology of this study consists of unit root tests, cointegration technique and error correction modeling approach. These are discussed below.

3.1. Unit Root Test

The unit root test checks the non-stationarity of the variables. We apply augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979 and 1981; Dickey et al, 1986; and Enders, 1995) to check non-stationarity of the variables.

The **augmented Dickey–Fuller test (ADF)** is a test for a unit root in a time series. It is an augmented version of the Dickey–Fuller test for a larger and more complicated set of time series models. The augmented Dickey–Fuller (ADF) statistic is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence. The testing procedure for the ADF test involves the regression of the following model:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_p \Delta y_{t-p} + \varepsilon_t, \quad (1)$$

where y_t is a variable of interest and ε_t is white noise error term, α is a constant, β the coefficient on a time trend and *p* the lag order of the autoregressive process. Imposing the contraints $\alpha = 0$ and $\beta = 0$ corresponds to modelling a random walk and using the constraint $\beta = 0$ corresponds to modelling a random walk with a drift. By including lags of the order *p* the ADF formulation allows for higher-order autoregressive processes. This means that the lag length *p* has to be determined when applying the test. One possible approach is to test down from high orders and examine the t-values on coefficients. An alternative approach is to examine information criteria such as the Akaike information criterion, Bayesian information criterion or the Hannan-Quinn information criterion.

The unit root test is then carried out under the null hypothesis $\gamma = 0$ against the alternative hypothesis of $\gamma < 0$. Once a value for the test statistic

$$DF_\tau = \frac{\hat{\gamma}}{SE(\hat{\gamma})} \quad (2)$$

is computed it can be compared to the relevant critical value for the Dickey–Fuller, Test. If the test statistic is less (this test is non symmetrical so we do not consider an absolute value) than (a larger negative) the critical value, then the null hypothesis of $\gamma = 0$ is rejected and no unit root is present. Otherwise , the alternative hypothesis is accepted, that is unit root is present. If the variable is differenced once and the differenced series is stationary, then it is integrated of order one [i.e., I(1)]. Similarly, if it is differenced twice and the differenced series is stationary, then it is integrated of order two [i.e., I(2)] and so on.

3.2. Cointegration

Cointegration means that despite being individually non-stationary a linear combination of two or more time series can be stationary; When a linear combination of non-stationary variables is stationary, the variables are said to be cointegrated and the vector that defines the stationary linear combination is called a cointegrating vector. The cointegration test was first introduced by Engel and Granger (1987) and then developed and modified by Stock and Watson (1988), Johansen (1988) and Johansen and Juselius (1990). The test is very useful in examining the long run equilibrium relationships between the variables. In this study, we use Johansen maximum likelihood (ML) approach to test for cointegration.

Let Z_t be a (n X 1) vector of variables with a sample of t. Assuming Z_t follows I (1) process, identifying the number of cointegrating vector involves estimation of the vector error correction representation:

$$\Delta Z_t = AO + \Pi ZX_{t-p} + \sum_{i=1}^{m} Ai\ ZX_{t-1} + \varepsilon t \qquad (3)$$

In the above equation, the vector ΔZ_t and ΔZ_{t-1} are I (1) variables. Hence, the long run equilibrium relationship among Z_t is determined by the rank of Π, say r, is zero, then equation reduces to a VAR model of p_{th} order and the variables in level do not have any cointegrating relationship. Instead, if $0 < r < n$ then there are *n x r* matrices of α and β such that

$$\Pi = \alpha \beta \qquad (4)$$

where the strength of cointegration relationship is measured by α, β is cointegrating vector and $\beta' Zt$ is I(0), although Z_t are I(I). In this framework, we have to estimate (A_0, A_1, A_2 .., A_{p-1}, Π) through maximum likelihood procedures, such that 'Π' can be written as in (6.3). To estimate all these parameters, we have to follow a two-step procedure. In the first step, regress ΔX_t on ΔX_{t-1}, ΔX_{t-2}, …., ΔX_{t-p+1} and obtain the residuals $\hat{u}_t$. In the second step, regress X_{t-1} on ΔX_{t-1}, ΔX_{t-2}, …., ΔX_{t-p+1} and obtain the residuals $\hat{e}_t$. The null hypothesis of no cointegration is tested against the alternative hypothesis of cointegration using the maximum eigenvalue and trace tests.

3.3. Causality

A cointegration vector between two variables leads to the possibility of causality between the two at least in one direction (Granger, 1988). Thus Granger causality test is used to examine the nature of the relationship (Granger, 1986; Engle and Granger, 1987). Granger Representation Theorem states that if variables are cointegrated then an error correction model (ECM) exists that combines the long run relationships with the short run dynamics of the model. Since our objective is to examine the causal relationship between education (edu) and economic growth (GDP), we specify the error correction model as follows:

$$\Delta GDP_t = \varphi_1 + \sum_{i=1}^{r} \gamma_i \Delta GDP_{t-i} + \sum_{i=1}^{s} \lambda_j \Delta EDU_{t-j} + \rho_1 ECT_{t-1} + \xi_t \quad (5)$$

$$\Delta EDU_t = \alpha_2 + \sum_{i=1}^{p} \alpha_i \Delta EDU_{t-i} + \sum_{i=1}^{q} \beta_i \Delta GDP_{t-j} + \rho_2 ECT_{t-1} + \zeta_t \quad (6)$$

where ECT_{t-1} is the lagged stationary residuals from the cointegration equation. Ordinary Least Squares (OLS) method are applied for the estimation and the standard t-statistics for testing the significance of each term since all the variables are stationary *[I (0)]*. We estimate the pair of equations for revenue expenditure on education and GDP, development expenditure on education and GDP, and total expenditure on education and GDP separately, if at least one of these coefficients must be significant in order that ECM holds. In order to determine the causality we use F-statistic. This F-statistic depends upon the restricted residual sum squares (RSS_1) and unrestricted residual sum squares (RSS_2).

$$F = \frac{(RSS_1 - RSS_2)/m}{(RSS_2)/(n-k)} \quad \text{and} \quad F \sim (m, n-k) \quad (7)$$

where, m denotes number of lags; k number of parameters involved in the model; and n is the sample size. If the estimated F-statistic is significant, the null hypothesis of the non-causality is rejected leaving the alternative hypothesis of causality accepted and hence we conclude that EDU causes GDP and vice versa. The non-causality hypothesis is accepted if the statistic is not significant leaving that EDU does not cause GDP and vice versa.

4. Econometric Results

Economic growth (GDP) and components of expenditure on education (EDU) during the period 1974 to 2008 are shown in Figures 2-3. These show that there exists the volatility in GDP as well as educational expenditures. It indicates that they have inherent tendency to move together towards equilibrium, although they drift apart from each other in the short run. This has been empirically established by using cointegration test and error correction modeling (ECM) technique. The first step of this process is to establish the order of integration and for this, we used Augmented Dickey Fuller (ADF) test. In the second step, Johansen cointegration technique is applied. Finally we apply error correction modeling (ECM) approach to assess the causality between the variables. Estimated results are discussed below.

4.1. Results of Unit Root Test

Augmented Dicky Fuller (ADF) test is used to test for the existence of unit roots and determine the order of integration of the variables. Test is done both with an intercept but not a trend and with an intercept and a linear trend and results are given in Tables 1 and 2. Results show that the variables, GDP, RE, DE and TEE, are non-stationary in levels. This means that they all have unit root problem and hence they suffer from instability problem in the short-run.

Table 1: Results of Unit Root Tests

	With an intercept but not a trend	With an intercept and a linear trend
GDP	5.0197	3.3197
RE	4.0667	3.2538
DE	1.0115	-1.6762
TEE	4.7155	4.9058

Note: 95% critical value for the Augmented Dickey-Fuller statistic = -2.9665; GDP = Gross Domestic Product, RE = Revenue Expenditure, DE = Development Expenditure, TEE = Total Educational Expenditure.

Results also show that the variables are stationary in first differences. This means that they are integrated of order one.

Table 2 : Results of Unit Root Tests: 1st difference of GDP, RE, DE, TEE

	With an intercept but not a trend	With an intercept and a linear trend
GDP	1.8517	0.15599
RE	2.4418	1.1571
DE	-2.2664	-2.8548
TEE	2.5416	3.4559

Note: 95% critical value for the Augmented Dickey-Fuller statistic = -2.9665. GDP = Gross Domestic Product, RE = Revenue Expenditure, DE = Growth Expenditure, TEE = Total Educational Expenditure.

4.2. Cointegration Results

The results of the cointegration tests are reported in Tables 3-5. Since the variables – GDP, revenue, development and total educational expenditure – are integrated of order one, it confirms the possibility of cointegration between the two. In other words, the long run equilibrium relationship between educational expenditure and GDP can be examined. We apply Johnasen's Maximum Likelihood (LM) cointegration technique to explore the possibility of long run equilibrium. The estimated results, particularly maximum eigenvalue and trace statistics, are presented in Tables 3-5.

Table 3: Cointegration between Revenue Expenditure on Education and Economic Growth

Null	Alternative	Test Statistic	95% Critical value	90% Critica Value
Maximum Eigenvalue test				
r = 0	r = 1	29.6913	14.8800	12.9800
r<= 1	r = 2	5.8870	8.0700	6.5000
Trace test				
r = 0	r>= 1	35.5783	17.8600	15.7500
r<= 1	r = 2	5.8870	8.0700	6.5000

Table 4: Cointegration between Development Expenditure on Education and Economic Growth

Null	Alternative	Test Statistic	95% Critical Value	90% Critical Value
Maximum Eigenvalue test				
r = 0	r = 1	27.3633	14.8800	12.9800
r<= 1	r = 2	6.3185	8.0700	6.5000
Trace test				
r = 0	r>= 1	28.2951	17.8600	15.7500
r<= 1	r = 2	6.3185	8.0700	6.5000

Table 5 : Cointegration between Total Educational expenditures and Economic Growth

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
Maximum Eigen value test				
r = 0	r = 1	27.7559	14.8800	12.9800
r<= 1	r = 2	1.1212	8.0700	6.5000
Trace test				
r = 0	R>= 1	28.877	17.8600	15.7500
r<= 1	r = 2	1.1212	8.0700	6.5000

Tables 3-5 indicate that both the maximum eignvalue test and trace tests give test statistics which are greater than the critical value for $r=0$. This means that the hypotheses of no cointegration are rejected and hence they are cointegrated. Tables also indicate that for r<= 1, the estimated test statistics are less than the critical value. Therefore we can say that GDP and educational expenditures are cointegrated with one cointegration vector. This means that GDP and components of educational expenditures have long-run relationships.

4.3. Results of Granger Causality

Since cointegration relationship is found between educational expenditure and GDP, an error correction model (ECM) could be constructed to determine the direction of causality. Granger causality theorem (1988) mentions that there should be at least one direction of causality between the two variables, if they are cointegrated. Accordingly, the causality model has been estimated and that has been tested by F-statistics. The estimated results are reported in Table 6. Results reveal that there is the presence of bi-directional causality between economic growth and education. Furthermore, results show the bi-directional causality between revenue expenditure on education and economic growth, and development expenditure on education and economic growth in Bangladesh.

Table 6: Status of Granger Causality

Direction	ECT	t-statistics	F-statistics
Gross Domestic Product and Total Expenditure on Education			
GDP ? TE	60315.4	5.9458	28.2118
TE ? GDP	2804.5	2.3691	9.6652
Gross Domestic Product and Development Expenditure on Education			
GDP ? DE	52309.9	4.7424	22.3711
DE? GDP	473.5277	2.3134	2.1567
Gross Domestic Product and Revenue Expenditure on Education			
GDP ? RE	61154.7	6.3682	32.6015
RE ? GDP	915.1793	2.5724	6.348

5. Summary and Conclusions

The research attempts to trace the causal relationship between GDP and revenue expenditure on education, GDP and development expenditure on education, and GDP and total expenditure on education separately in Bangladesh during the period 1974 to 2008. The relationship between GDP and education can take three forms. GDP can cause education to grow, these can help each other to grow and education can cause GDP to grow.

We apply augmented Dickey-Fuller test, cointegration and error correction modeling (ECM) technique to assess the causality relationship.

Results from augmented Dickey-Fuller test show that both economic growth and components of educational expenditure are non-stationary at the level but found stationary at the first differences, indicating that they are integrated of order one.

Johansen cointegration results reveal that economic development and revenue, growth and total expenditure on education are cointegrated. This indicates existence of long run equilibrium relationships between GDP and components of educational expenditures.

The Granger causality test finally confirms the presence of bi-directional causality between education and economic growth. This means that economic growth and education causes each other to grow. In Bangladesh, economic growth and educational expenditure are working in tandem.

Therefore, we would like to conclude that since education is causing economic growth to improve, the government should continue to spread education, specially quality and technical education in order to keep up with and boost this long-run cointegration and causal relationship between education and economic growth.

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