Examining a Co-integration and Causality between Education and Economic Growth in India

Abstract:

The study examines the empirical relationship between education expenditure, higher education and economic growth in the context of India using time series econometric analysis for the time period 1971-2015 based on Vector Autoregression (VAR) model and Johansen's Cointegration procedure. The time series data were verified for the stationary properties by using Augmented Dickey Fuller and Phillips-Perron test techniques which showed the variables to be integrated of order one I(1). The Johansen co integration of trace and maximum Eigen value tests indicated the presence of one co-integrating relationship among the variables, that is, the existence of long run relationship among the variables under investigation. The Granger causality test results indicated a unidirectional causality that runs from government expenditure on education to economic growth and also the existence of unidirectional causality between higher education and economic growth that run from economic growth to higher education. The reverse causality did not hold in either cases. The error-correction mechanism gives evidence for the short-run dynamics. Impulse Response Function showed a sharp drop initially of GDP and then positive response of GDP to shock in education expenditure and higher education that appeal for productive investment in research and development and training with proper facilities and establishment of more educational institutions, particularly higher education institutions that will lead to higher economic growth of India.

Keywords: Education Expenditure, Higher Education, GDP Per Capita, VAR Model, Granger causality, Impulse response, India.

1. Introduction

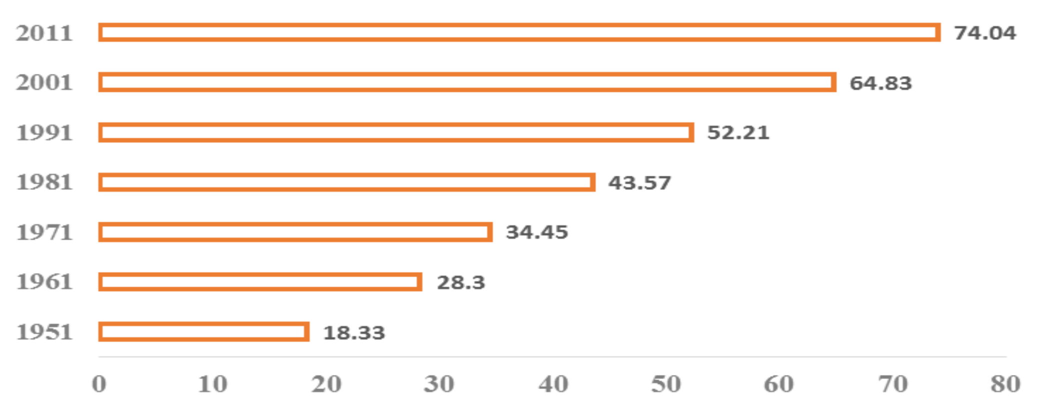
India is one of the fastest growing developing economies with third largest education system after US and China. It sets its goal of achieving $5 trillion economy by 2024 which largely depends upon, among other factors, the key factors of human capital and higher education. The present paper is undertaken to empirically examine whether human capital (measured in terms of government expenditures on education) and higher education (measured in terms the gross enrolment ratio in tertiary education) affect economic growth of India. This will help policymakers and national leaders to formulate strategies for achieving the targeted goal relating education to growth in the future. Education is deliberated as one of the most important aspects of overall human capital investments which includes health and other aspects of social capital. It hardly needs any justification that education carries utmost importance because it functions as an engine of economic growth, development and prosperity for any nation. In the current globalized knowledge-based economy, talented and skilled manpower in sufficient quantity capable of meeting future challenges thrown up by disruptive technology and big geo-political changes is anticipated strategically more crucial than ever before to win the global competition in future (IEPSI & IMC, 2019). Today, many developed nations are ahead from developing countries in every domain of the socio-economic and political indicators of sustainable development, because they prioritized education for substantial investment in human capital for improving both its quantity and quality aspects. Investment in education leads to the formation of human capital, comparable to physical and social capital, and that makes a significant contribution to economic growth (Babalola, 2011; Pradhan, 2009; Dicken et al., 2006; Loening, 2004; Barro, 2001). Education converted into labour productivity by accumulating knowledge and skills of the labour force and by facilitating the technological progress and innovation, not only leads to formation of human capital of an economy but various aspects like health, nutrition and sanitation are also positively affected (Mariana, 2015; Chandra, 2010).

The relationship between human capital/education and economic growth was established since long. Over the period of time, many growth theories and models have been developed that predict that education has a positive effect on growth. The major theoretical contributions to the subject on the relationship between education and economic growth are the augmented neoclassical and endogenous growth theories developed by among other, Solow, 1957; Lucas, 1988; Romer, 1990;

Mankiw, et al., 1992. Many studies and theoretical advancement on the education and growth nexus have been made from time to time all over the world by Becker, Denison, Dholakia, Harbison and Myers, Mukherjee and Rao, Psacharopoulos, Schultz, Solow, Tilak and Todaro (Goel & Walia, 2017). The theoretical approaches and modellings involving education and growth nexus in common have predicted that education has a positive effect on economic growth (Hanushek & Woessmann, 2012). They also stress its impact on long-run growth trajectories through its role in increasing the innovative capacity of the economy (Aghion and Howitt, 1998; Romer, 1990), and its role in facilitating the transmission and diffusion of knowledge needed to implement new technologies (Benhabib and Spiegel, 2005; Nelson and Phelps, 1966).

The Government of India has acknowledged the centrality of education in economic growth since the time of independence. Therefore, government of India and state governments have taken several initiatives from time to time and with the introduction of liberalized policy measures in the early 1990s towards private sector involvement in the higher education, considerable growth of higher education in India has been witnessed in post-90s since new colleges and universities were established in every part of the country. In the country in 1950-51, there were only 28 universities and 578 colleges which has increased manifold to 903 universities and 39,050 colleges in 2017-18 as a result of the involvement of private sector in the higher education (All India Survey on Higher Education-various issues). The literacy rate is a prime indicator of socio-economic and educational status of any country including India. The following figure-1 demonstrates the growth trend of literacy rate since 1951.

Fig.1: Literacy Rate in India



Source: 2001 and 2011 Census Report of India

It can be observed from the figure-1 that the literacy rate which was just around 18% in 1951 has increased to over 74 percent in 2011 as per Census report of India. There is more than 24 percent point increase in literacy rate since 1951 to 2011. There is also a significant rise in the number of students enrolled in higher education institutions which increased from 0.15 million in 1950-51 to 14.3 million in 2005-06 and then to about 36.6 million is 2017-18. Large numbers of graduates and post-graduates passing out each year from these institutions are supposed to be one of the contributing factors to steady and consistent economic growth during post 1990s. The government expenditure on education has been increased over the years, and the education expenditure (as a share of GDP%) which started off at just 0.64% in 1951 has gradually increased to around 4 to 4.5 percent in recent years. Thus, the tremendous efforts made by the people of India, national leaders, policy makers as well as government through various reforms measures from time to time for improving the education sector both quantitative and qualitatively in the post era of 1990s and 2000s has led to a speedy growth stage of the economy about 10 percent in most recent years establishing the direct relation between higher education growth and economic growth. In essence, there has been significant growth taken place in education, especially in higher education due to which national income and GDP Per capita income has increased manifold in India. Ahead this background, the present paper attempts to empirically investigate the linkages between the education and economic growth in the context of India.

The studies that exist in the Indian context (Indira & Kumar, 2018; Mallick & Dash, 2015; Ray et al., 2012; Chandra, 2010; Pradhan, 2009; Ansari & Singh, 1997) provide contradictory evidence on the relevance of the education expenditure and higher education on economic growth. There is a paucity of empirical studies on the exploration of the linkage between higher education and economic growth (GDP per capita) in the Indian context and this study tries to consider this using a different choice of variables, namely, government education expenditure (as a share of GDP%), the number of students enrolment in tertiary education (Gross Enrolment Ratio) and GDP Per Capita (economic growth). As the evidences of the existing studies are not very conclusive on the direction and the strength of linkage between education development and economic growth, particularly in the Indian context, it is interesting and relevant to empirically investigate the relationship among them considering the level of educational development with an increase in public expenditure in education sector and enrolment ratios in higher education and economic development for more than two decades in India. Towards this end, the study employs VAR methodology with the error correction model (ECM) and time series techniques of Johansen cointegration of trace plus maximum Eigen value tests to explore the possible links between education expenditure, higher education and economic growth in India for the period 1971-2015. Specifically, we use Granger Causality tests and impulse response function that detects the direction of causality and identify which variable is a determining factor for one another variable under investigation in the context of India. We will investigate the following specific objectives:

- To examine the causal interrelationship among government expenditure on education, higher education and economic growth in India.
- To estimate the long run relationship and short run dynamics of government education expenditure, higher education and economic growth in India.

The main empirical findings from this study reveal that there is a long run relationship between government expenditure on education, higher education enrolment ratio and GDP per capita in India for the period 20171 to 2015. The Granger causality test results indicated a unidirectional causality that runs from government spending on education to economic growth and from economic growth to higher education while the reverses did not hold. The error-correction mechanism (ECM) gives evidence for the short-run dynamics. The rest of the paper is organized as follows: Section 2 provides a brief overview of theoretical studies and empirical evidence relevant to this study and Section 3 states the specific objectives of this study. Section 4 discusses the nature of data and data source and methodological framework used in this study while Section 5 provides the empirical results and the main findings of the study, and finally, Section 6 contains summary and conclusion.

2. Review of Literature

The centrality of education for economic growth has been acknowledged since the time of Adam Smith and Marshall and have overtime evolved many economic growth theories and models. The main theoretical models that link between education and economic performance are the neoclassical growth models of Solow (1957) and Romer (1990), Mankiw et al. (1992) and endogenous growth models of Lucas (1988), Aghion and Howitt (1998). The economic growth models emphasized different mechanism that links education to growth and all approaches predict that education has a positive effect on growth. More importantly, growth theories and models predict positive externalities (education investments' fostering technological innovation, thereby making capital and labor more productive, generating income growth) and spillover effects (other than improving labour productivity and benefiting the individuals who receive it) from development of a high valued-added knowledge economy to the development and maintenance of a competitive advantage across the globe (Babalola, 2011; Aghion, et al., 2009; Self & Grabowski, 2004). Apart from the theoretical approaches, numerous empirical studies have focused on the interrelationship between education and economic growth (Benosa & Zotou, 2013; Barro, 2013; Chandra, 2010; Pradhan, 2009; Loening, 2004).

Although the consensus in the theoretical approaches of modeling linkages between education and economic growth seems to establish a significant positive linkage between education and growth, such that education increases labour productivity, efficiency gains of labour force, thereby causingf higher growth and development; however, the empirical evidence is rather not unanimous and remains controversial. Up to the present moment, there have been different and sometimes conflicting empirical evidences in both cross-country and country specific education-growth nexus analyses (Benosa & Zotou, 2013). Among other factors, differences in data used, data measurement and definitions such as human capital, or education and growth, methodological approaches, model specification and time frame have been identified as a major factors responsible for these variances. More explicitly, Temple (2001) points out that the empirical relationship between education and growth is often weak and the fragile correlations in cross-country data due to large measurement errors and influential exceptions. Consequently, the empirical evidences on the presence of a relationship between education and economic growth, despite strong background of theoretical predictions, have long been inconclusive and unclear.

More specifically, in the context of India, despite rigorous empirical exercises on the relationship between education and economic growth, the evidences as regards to the impact and direction of causality relationship between education and economic growth remain ambiguous. For example, Self and Grabowski (2004) indicated a strong positive causal impact of primary education, but a more limited impact for secondary education and no causal impact of higher (tertiary) education on economic growth in the period 1966–1996 in India. Tamang (2011) indicated a lesser impact of education expenditure on economic growth as compared to physical capital per labour for the period 1980-2008 in India. A study by Pradhan (2009) using error correction modeling confirmed unidirectional causality between education and economic growth, the direction of causality runs from economic growth to education in the period 1951-2001, while Ansari and Singh (1997) found no long run relationship between the two in the period 1951-1987. On the other hand, studies by Mallick and Dash (2015) for the period 1951-2012 and Abubakar and Abdulkadir (2015) for the period 1980 to 2012 indicated a unidirectional causality that runs from education expenditure to economic growth. Furthermore, Ray, et al. (2012) did not find Granger causality between economic growth and education over the period 1961-62 to 2009-10, but, Chandra (2010) using linear and non-linear Granger Causality methods revealed a bi-directional causality between the two for the period 1951-2009.

One observes from the review of literature above that education and economic growth are positively associated; nonetheless, the empirical results are not very conclusive on the direction and the strength of linkage between education growth and economic growth, particularly in the Indian context. Thus, this is a researchable issue and to fill this research gap, the present study is conducted in India with a view to understanding the nature and direction of causality between education and economic growth.

3. Data and Research Methodology

The main aim of the present paper is to examine the interrelationship between education and economic growth in India, using annual time series data for the period 1971 – 2015. Towards this end, annual time series data of gross domestic product (GDP) per capita (lngdp_pc), education expenditure by government of India as a share of GDP (lngex_ed) and higher education (lnger_he), for the period 1971 – 2015 are collected from various secondary sources like National Accounts statistics published by CSO, Analysis of Budgeted Expenditure on Education of Various Years, Hand Book of Statistics on Indian economy, Reserve Bank of India, Ministry of Human Resource Development, Government of India, and World Development Indicators website to investigate the causal relationship among the variables in the framework of Vector Autoregression (VAR) system and Granger causality technique. The number of enrolled students in tertiary (higher) education institutions, measured as gross enrolment ratio is used as proxy of higher education variable. The government expenditure on education captures the growth of overall education expenditure (as a percentage of GDP) and the GDP per capita (constant US$) is a proxy of economic growth during the period of analysis. All the data of time series variables are transformed using the natural logarithm.

The econometric approach of this paper is based on the vector autoregressive (VAR) model that allows us to study the inter-relationships between the variables. The methodology involves carrying out stationary test, then cointegration test and depending on the co-integrated relationship among the variables, error–correction model (ECM) is applied before proceeding with Granger causality method (Shafuda and De, 2020). Testing of stationary is important because most time series variables have unit roots or random walk (i.e., non-stationary) dominated over time mainly by stochastic trends. Such trended time series may potentially create spurious regression results and could undermine the policy implications (Engle and Granger, 1987) and therefore the unit root properties in chosen variables herein are tested by applying the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. Variable having unit roots at level are said to be integrated of order zero (I (0), while the one that becomes stationary, after first differencing is integrated of order one I(1). The ADF unit root test estimate the following regression equation:

$$\Delta \mathbf{y_t} = \boldsymbol{\alpha} + \boldsymbol{\beta} \mathbf{y_{t-1}} + \sum_{\mathbf{i=1}}^{\mathbf{p}} \boldsymbol{\delta}_\mathbf{i} \Delta \mathbf{y_{t-i}} + \boldsymbol{\varepsilon}_\mathbf{t} \qquad (\mathbf{1})$$

Where, y_t is the choice variable; Δ is the first difference operator; **p** is the number of optimal lags to be identified ensuring that the error term (ε) is a white noise. **α, β** and **δ** are parameters that to be estimated. If the coefficient $\boldsymbol{\beta} = \mathbf{0}$ the equation is entirely in first difference and the variable contains a unit root, i.e., non-stationary. Thus, when the coefficient, $\boldsymbol{\beta} \neq \mathbf{0}$, the null hypothesis that the series has unit root is rejected and the series stands stationary. This is decided by the estimated greater value (in absolute term) of the ADF test statistic than the 5% critical value.

Unlike the ADF tests, the Phillips–Perron (PP) tests are robust pertaining to unspecified autocorrelation and heteroscedasticity in the innovations process **($\boldsymbol{\varepsilon}_\mathbf{t}$)** of the test equation and the user does not have to specify a lag length for the test regression (Phillips & Perron, 1988). The PP test involves fitting the following regression equation:

$$\Delta \mathbf{y_t} = \boldsymbol{\alpha} + \Delta \mathbf{y_{t-i}} + \boldsymbol{\varepsilon}_\mathbf{t} \qquad (\mathbf{2})$$

Where Δ is the first difference operator.

After unit roots of all the series have been confirmed, the tests for the existence of long run relationship among the variables are to be performed. Testing for co-integration is an important step to check if there is an empirically meaningful long-run relationship between the variables (Shafuda & De, 2020). The existence of a long-run equilibrium relationship among economic variables has been referred to as cointegration in the economic literature. The Co-integration tests technique developed by Johansen (1988) and Johansen and Juselius (1990) is employed for testing the long run relationship between education spending, higher education and economic growth. The Johansen approach applies the maximum likelihood principle for determining the presence of cointegrating vectors in the framework of non-stationary time series autoregressive vector (VAR) model. Proceeding with the methodology of Johansen (1988) and Johansen and Juselius (1990), the VAR model with p-lags is written as:

$$\mathbf{y_t = m + A_1 y_{t-i} + A_2 y_{t-2} + \cdots\cdots\cdots + A_p y_{t-p} + \varepsilon_t} \qquad (3)$$

Where, $\mathbf{y_t = (y_{1t}, y_{2t}, y_{3t})'}$ is a **3 x 1** vector of endogenous variables (economic growth, higher education and government education expenditure) with $\mathbf{y_{1t}}$**= lngdp_pc,** $\mathbf{y_{2t}}$**=lnger_he,** $\mathbf{y_{3t}}$**= lngex_ed**; **m** is the **3 x 1** vector of intercepts; $\mathbf{A_1}$–$\mathbf{A_k}$ are **3 x 3** matrix of coefficients with the k[th] lag of $\mathbf{Y_{t-k}}$; **p** is the lag length; $\boldsymbol{\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t})'}$ is the **3 x 1** vector of residual terms (a white noise) of pure random process.

The specification of VAR model should decide how many lags to be included in the model. Several information criteria are available in the literature for deciding the number of optimal lags length such as Akaike Information Criteria (AIC), Schwartz Bayesian Criteria (SC), Hannan-Quinn information criteria (HQ), Final prediction error (FPE) and likelihood ratio test (LR), but our optimal lag length is based on the lowest values of AIC, HQ and FPE criteria.

The Granger's representation theorem states that if variables are co-integrated and each is individually I (1), at least a unidirectional causality exists (Granger, 1988). The VAR model (equation 3) after variables are integrated and co-integrated, can be transformed into a Vector Error Correction (VEC) model as follows:

$$\mathbf{\Delta y_t = m + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i y_{t-i} + \varepsilon_t} \qquad (6)$$

Where, $\mathbf{\Pi = \sum_{j=1}^{j=p} A_j - I_k}$ **and** $\mathbf{\Gamma_i = \sum_{j=i+1}^{j=p} A_j}$.

The matrix $\mathbf{\Pi}$ expresses information regarding the long-run effect of the $\mathbf{y_t}$ variables in the vector, and $\Gamma_{\mathbf{i}}$ are matrices that measures the short term impact. If all the variables in $\mathbf{y_t}$ are stationary and integrated at order one and the matrix has the cointegrating rank, **0 < r < 3**, then the matrix **Π** can be decomposed into two **3×r** matrices, **α** and **β**, such that **Π=αβ'** where, the elements of **α** are known as feedback coefficient (error correction mechanism) characterizing the speed of the adjustment parameters while **β** represents the matrix of parameters of **r** linear cointegrating vector such that $\boldsymbol{\beta' y_t}$ is stationary. Testing of the β-coefficients determines whether the variables are entering the cointegrating relationship significantly. The co-integration between variables is very important to confirm the Granger causality tests because if the variables are non-stationary and not cointegrated the Granger causality tests are not valid. The VEC model can be re-written now as:

$$\Delta \mathbf{y_t} = \mathbf{m} + \boldsymbol{\alpha\beta' y_{t-1}} + \sum_{\mathbf{i=1}}^{\mathbf{p-1}} \Gamma_{\mathbf{i}} \mathbf{y_{t-i}} + \boldsymbol{\varepsilon_t} \qquad (3)$$

Where $\boldsymbol{\alpha\beta' y_{t-1} = \mu_{t-1}}$ indicates the stationary residual vector.

Applying Johansen's method for testing for cointegrating vectors involves testing for the rank **r**, of the matrix **Π**. The cointegrating rank **r** of **Π** is achieved by inspecting whether the eigenvalues of Π are significantly different from zero. To examine the same, two most popular likelihood ratio tests statistics, namely, the trace test ($\boldsymbol{\lambda_{trace}}$) and the maximum eigenvalue test ($\boldsymbol{\lambda_{max}}$) are proposed in the literature (Johansen & Juelius, 1990) and both are applied in this paper. Both the tests are defined as follows:

(i) **Trace test:** The likelihood ratio of this test statistic is given by:

$$\boldsymbol{\lambda_{trace}} = -\mathbf{T} \sum_{\mathbf{i=r+1}}^{\mathbf{k}} \mathbf{ln}(\mathbf{1} - \boldsymbol{\lambda_i}) \qquad (4)$$

Where, $\boldsymbol{\lambda_i}$ are the estimated **T-r** eigenvalues (smallest) obtained from the estimated **Π** with sample size **T**. The null hypothesis (H_0) to be tested is that there are at most r cointegrating vectors. That is, the number of cointegrating vector is less than or equal to **r** against the alternative hypothesis (H_1) of **k** cointegrating relations until the null hypothesis of $\mathbf{H_0: r = k}$ is reached. The rejection of the null indicates the existence of at most r cointegrating vectors.

(ii) **Max Eigen Test:** This test tests the null hypothesis of r cointegrating vectors against r+ 1 cointegrating vectors with r = 0, 1, 2. Both these test statistics have a non-standard distribution. The maximum eigenvalue test proved to be relatively more powerful than of trace test, whereas trace test is more robustness to the non-normality of errors. Its likelihood ratio statistic is given as:

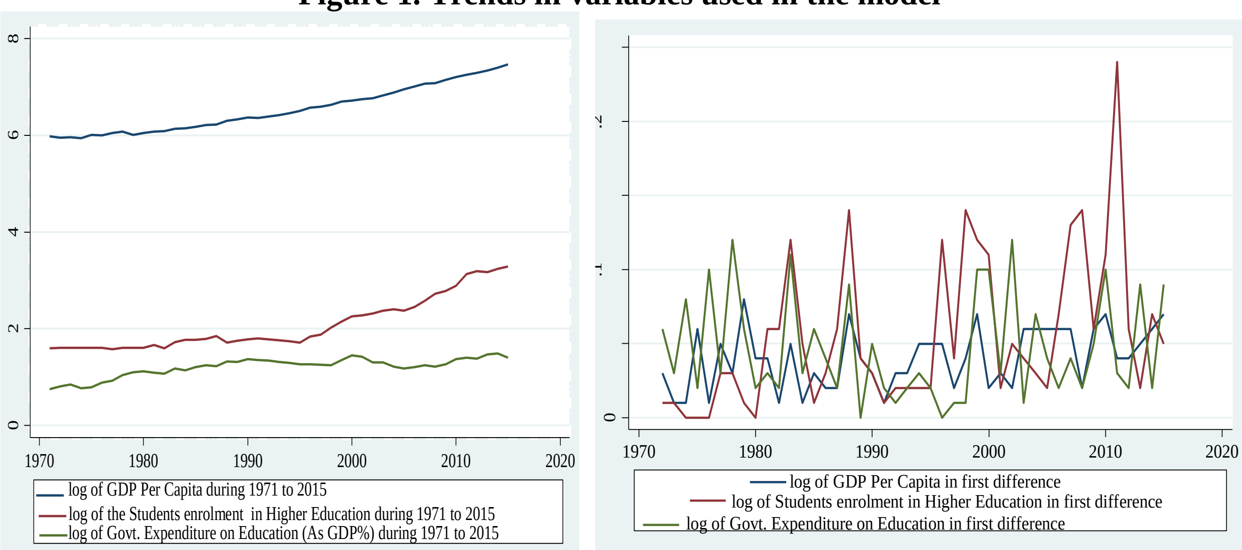
$$\lambda_{max} = -T\ln(1 - \lambda_{i+1}) \quad (5)$$

The critical values for the two statistics are provided (Johansen & Juselius, 1990) and compared with the estimated values of the two test statistics for possible rejection or acceptance of H_0 against H_1.

4. Empirical Results and Discussions

This section discusses the main empirical findings based on the methodologies outlined in section 3. A graphical representation of the three variables in Figure 1 shows upward trending of time series variables, thereby indicating the possibility of a unit root in all the three variables. This implies that GDP per capita, gross enrolment ratio in higher education level, and public expenditure on education (as percentage of GDP) all have increased from 1971 to 2015. This provides an indication of a positive impact of education and higher education in particular in the growth of the Indian economy.

Figure 1. Trends in variables used in the model



4.1 Unit Root Tests of the Variables

For meaningful prediction to have by avoiding spurious results in regression model, the first step is to examine the unit root (stationarity) properties of the time series. Both ADF and Phillips-Perron unit roots were applied to test the check the stationarity (the order of integration) properties and the results are summarized in Table 1. A glance at the table -1 reveals that the tests results failed to reject the null hypothesis (H_0) of non-stationarity indicating unit root at level form for all variables considered. However, the null hypothesis is rejected at first difference level, implying that all the three time series are integrated at order one, I(1). The same results have been obtained using the Phillips-Perron test. Figure-2 demonstrates that all the first differenced variables have constant mean-reversions around zero, that is., the gross enrolment ratio in higher education, government education expenditure and GDP per capita are all stationary about the mean (Figure-2).

Table 1. Results for the ADF and Phillips-Perron tests (trend regress)

Variables	**ADF Test**		**PP Test**	
	At Level	First difference	At Level	First difference
lger_he	-0.812	-4.329***	-0.690	-4.933**
Lgdp_pc	-1.252	-4.527***	-1.752	-6.905***
Lgex_ed	-2.069	-3.744***	-2.126	-7.693***

***Denotes rejection of the null hypothesis at the 1 percent levels of significance.

4.2 Johansen Co-Integration Test and Error–Correction Model

All the three variables have shown to be stationary and integrated of same order of 1(1) and we now examine the existence of long run relationship, that is, co-integration among them by employing Johansen's maximum likelihood co-integration method. Table 2 summarises the results of Johansen Cointegration test which indicates both estimated values of the trace and max eigenvalue tests. A perusal of the table 2 provides the evidence that there is at least one co-integrating vector among GDP Per Capita, education expenditure and higher education for the study period. This has been confirmed by rejecting the null hypothesis of no cointegrating vector at the 5% level critical values of both the trace-statistic and maximum eigenvalue statistics. The values of trace and maxeigen tests are found greater than the 5% critical value when rank = 0 and when rank = 1, both tests estimated at lower than the 5% critical value (Table-3). Thus, we can conclude that there is at least one cointegrating relationship between the variables indicating that education expenditure, higher education and economic growth establish a long run relationship in India. This finding is consistent with Pradhan (2009), Abubakar and Abdulkadir (2015) and Mallick and Dash (2015).

Table 2: Results of Johansen cointegration test for long run equilibrium

Maximum rank	**Eigenvalue**	λ_{trace}	λ_{max}	**5% Critical value**	
				λ_{trace}	λ_{max}
0	-	35.4597	23.4244	29.68	20.97
1	0.42002	12.0352*	9.5911	15.41	14.07

2	0.19992	2.4442	2.4442	3.76	3.76
3	0.05526				

Trend: constant; Number of obs =43 Sample: 1973 – 2015; Lags = 2;
*Level of significance at 5%.

Table 3 shows the Johansen normalization restriction (β') of the variables in the model.

Table 3: Normalized Cointegration Eigenvector (β')

Cointegrating Equation	Coefficients & t-values
lngdp_pc	1.000000
lngex_ed	-.1126071 (-0.53)
lnger_he	-.4508074 (-5.35)***
_cons	-5.215298

Note: Figures in parenthesis are t-values;
***Significant at 1% level of significance

The long run cointegrating equation is derived in equation (6) as follows:

$$\boldsymbol{lgdp\_pc = -5.215298 + (-.1126071)lgex\_ed + (-.4508074)lger\_he} \quad (6)$$

The equation carries all the coefficients of the variables negative sign showing positive long run equilibrium relationship among them correctly. The cointegrating equation shows that a 1% increase in the number of students enrolled in higher education leads to a 0.45% increase in GDP per capita implication that higher education has a significant positive effect on economic growth. This is confirmed by the t-value (t=-5.35) of the coefficient of higher education which is statistically significant at 1% level. However, the impact of government education expenditure on the economic growth is negligible since it is insignificant. This points towards emphasizing more importance to the development of higher education as crucial factors in promoting development of Indian economy as compared to education expenditure.

Table 4: ECM and Short-run Equilibrium Dynamics

Coefficients	Δlngdp_pc	Δlngex_ed	Δlnger_he
Ect_1	0.080 (3.62)***	-0.052 (-0.89)	0.157 (2.89)***
Δlngdp_pc(-1)	-0.279 (0.061)	0.126(0.32)	0.141(0.39)
Δlngex_ed(-1)	-0.173(-2.60)***	0.034(0.19)	0.322(1.97)**
Δlnger_he(-1)	-0.060(-1.01)	0.058(0.37)	0.011(0.08)

constant	0.031 (5.29)***	0.019 (1.27)	-0.009 (-0.66)

Note: Figures in parenthesis are t-values; ***Significant at 1% level; **Significant at 5% level

The error correction equations with the analogous of Table 4 are as follows:

$$\Delta lngdp_{pc_t} = 0.031 - \mathbf{0.279}\Delta lngdp_{pc_{t-i}} - \mathbf{0.060}\Delta lnger_{he_{t-j}} - \mathbf{0.173}\Delta lngex_{ed_{t-m}} + \mathbf{0.08}ECT_{t-1} \quad (7)$$

$$\Delta lnger\_he_t = -\mathbf{0.009} + 0.14\Delta lngdp_{pc_{t-i}} + \mathbf{0.011}\Delta lnger_{he_{t-j}} + \mathbf{0.322}\Delta lngex_{ed_{t-m}} + \mathbf{0.156}ECT_{t-1} \quad (8)$$

$$\Delta lngex\_ed_t = 0.019 + \mathbf{0,126}\Delta lngdp\_pc_{t-i} + \mathbf{0.058}\Delta lnger\_he_{t-j} + \mathbf{0.034}\Delta lngex\_ed_{t-m} - \mathbf{0.051}ECT_{t-1} \quad (9)$$

The results in Table 4 of Vector error Correction Model (ECM) is indicated by the cointegration results assures the existence of the short-run dynamics of the model. The results of the ECM confirm the cointegration results and indicate the presence of error correction term for education expenditure in the long-run after short-run shocks. The error correction term (Ect_1) for GDP per capita, and higher education are estimated to be positive signs which mean that there is absence of long run dynamics of GDP Per Capita as well as higher education while education expenditure does have but it is not significant. The short run dynamics of GDP and higher education suggests that there is no problem of adjustment in the long-run in case of shock in the short-run as the values are significant. The findings are recapitulated in equation 7, 8 and 9.

Table 5 reports the VECM diagnostic tests where we cannot reject the null hypothesis of no serial residual correlation at lag order of LM (Lagrange Multiplier) test. The test results of Skewness, Kurtosis and Jarque-Bera for normality of the model support that the residuals are normally distributed. The stability check also indicate that the model is well-specified. This is because the moduli of 3 eigenvalues are strictly less than one, placed inside of the unit circle, thereby confirming stability condition of our VEC model.

Table 5: VEC Model Diagnostic Tests

Serial residual autocorrelation test for the model
H_0: No serial correlation; Alternative hypothesis, H_1: Serial correlation LM(1) χ^2 =5.0673, p- value = 0.82480, Null hypothesis (H_0) accepted LM(2) χ^2 =8.5080, p- value =0.48387, Null hypothesis (H_0) accepted

Normality test for the model

H_0: Residuals are multivariate normal; Alternative, H_1: Residuals are not multivariate normal

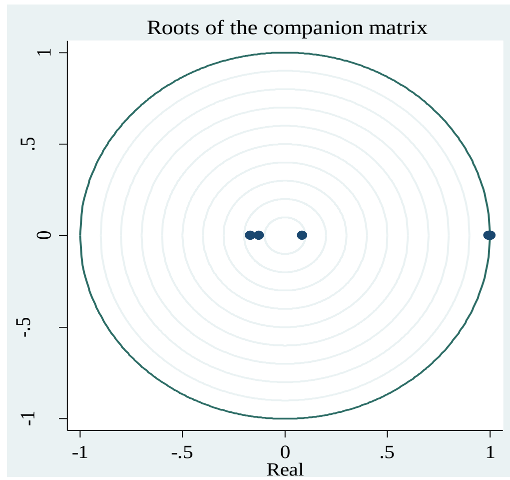
Skewness χ^2 = 2.960, p-value = 0.39787, Null hypothesis (H_0) accepted

Kurtosis χ^2 = 4.654, p-value = 0.19895, Null hypothesis (H_0) accepted

Jarque–Bera χ^2 = 7.614, p-value = 0.26778, Null hypothesis (H_0) accepted

Check for Stability of the VEC estimates: Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
.9942341	.994234
-.1704503	.17045
-.1266108	.126611
.08388976	.08389



The VECM specification imposes 2 unit moduli.

4.3 Granger causality Wald tests

There is growing interest in the causal relationship between economic growth and education especially in the context of development strategies, mainly in developing countries. The direction of causality among GDP per capita, enrolment in higher education and government educational expenditure from 1973-2015 are studies based on the VAR estimated results by using Granger causality wald tests. Table 6 presents the results of pairwise Granger causality among the GDP per capita, educational expenditure and higher education enrolment.

Table 6: Pairwise Granger causality Wald tests Analysis

Null Hypothesis (H_0)	**χ^2 Statistic**	**Decision**	**Direction of Causality**
Economic growth does not Granger cause expenditure on education	0.91737	Accept H_0	Unidirectional from expenditure to GDP per capita
Govt. expenditure on Education does not Granger Cause Economic growth	11.806***	Reject H_0	

Economic growth does not Granger cause higher education Higher education does not Granger Cause Economic growth	9.8089*** 3.9341	Reject H_0 Accept H_0	Unidirectional from GDP per capita to Higher education
Govt. expenditure on Education does not Granger Cause Higher education Higher education does not Granger Cause Govt. expenditure on Education	2.3177 0.71067	Accept H_0 Accept H_0	No Causality

The results show that the null hypothesis that educational expenditure by government does not Granger cause GDP per capita is rejected at 1 percent level of significance. This implies that educational expenditure does Granger cause economic growth through its contribution to human capital, and consequently government spending on education is helpful in predicting the economic growth. Similarly, the null hypothesis that economic growth does not Granger causes higher education is statistically rejected at 1 percent level of significance, thus implying a direct causality from economic growth rate to the number of students enrolled in higher education. However, null hypotheses that GDP Per Capita Granger causes government expenditure, higher education Granger causes GDP Per Capita and Granger causality between government expenditure on education and higher education could not be rejected, indicating no causality between them as estimated by Granger causality Wald tests. Thus we can conclude that there exists a unidirectional causality which runs from government expenditure on education to economic growth and from GDP per capita to higher education performance in enrolment rates, while reverse are not hold. These results are consistent with similar studies by Pradhan (2009) and Mallick and Dash (2015) but contrast with study by Indira and Kumar (2018) who indicated a weak relationship between the student enrollment in higher education and GDP in India.

4.4 Impulse Response Function (IRF)

To trace out the time path of the various shocks on the variables contained in the VAR system, the IRF is demonstrated in figure-3 which shows the response of variables following a one standard deviation innovation or shock on the error term.

Figure-3: Response to Cholesky One S.D. Innovations ± 2 S.E.

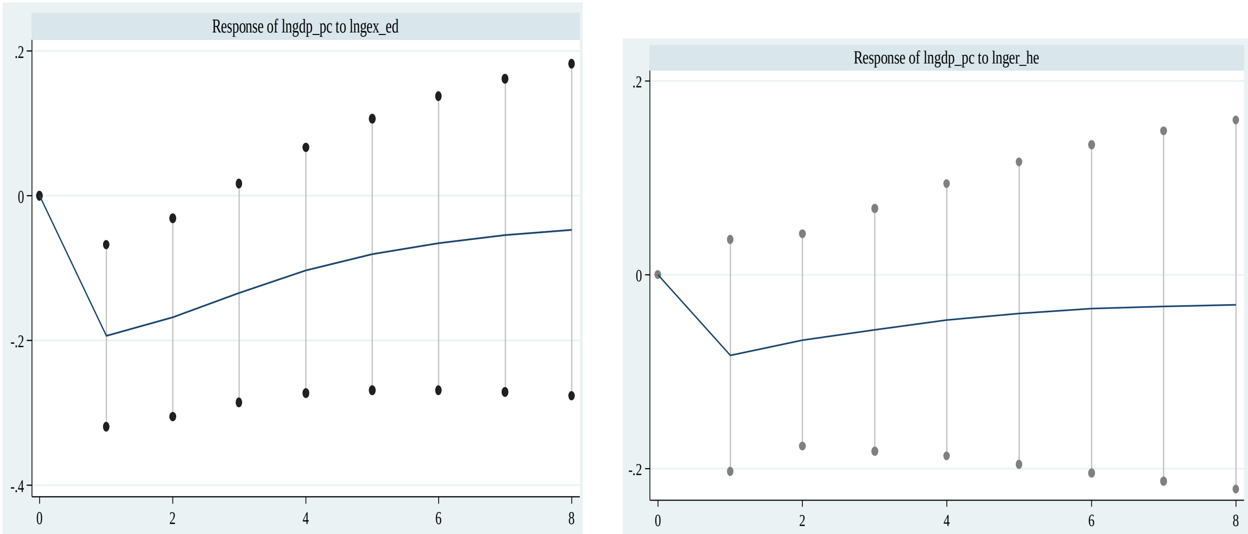
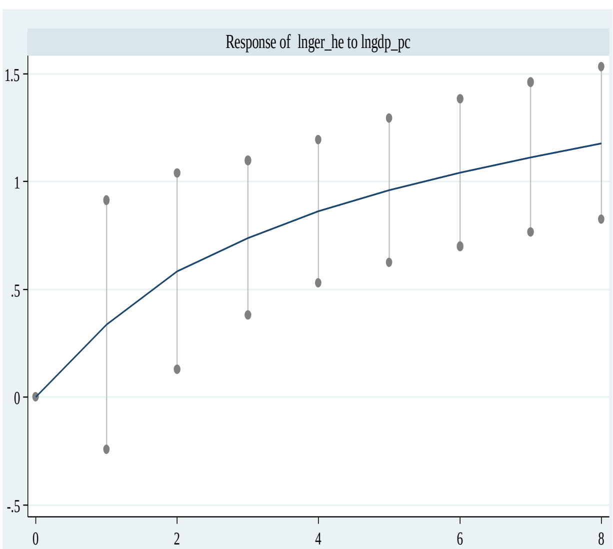


Fig.3(a) &(b): The impulse-response function of the GDP per capita



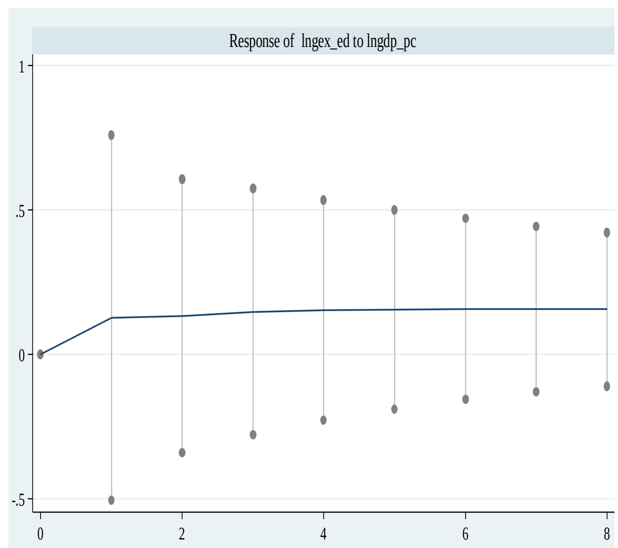


Fig.3(c): The impulse-response function of the higher education
Fig.3(d): The impulse-response function of the education expenditure

The first row in the IRF above shows the responses of GDP to a shock in education expenditure and higher education. Thus an impulse in the education expenditure causes a sharp decline in GDP per capita in the first years then follows an increase in the long-run, though it is still negative. Likewise, an impulse in the number of students enrolled in higher education causes a sharp drop in GDP per capita in the first years then follows an increase in the long-run which is still negative. Contrary to this, an impulse in the growth of GDP Per Capita witnessed a sharp rise in initial years and then an exponential rise in the number of students enrolled in higher education in the long run.

The responses of educational expenditure (lngex_ed) to GDP Per Capita was zero in the initial period but afterwards it began to increase positively and reached its peak in the second period and then continue to maintain that level in the long run.

5. Summary and Conclusion

The objective of this paper was to show the linkage between education expenditure, higher education and real GDP Per Capita. In other words, we attempted to understand how these variables have contributed toward the growth of an economy in relation to the human capital development. Using various econometric and time-series tools, we conclude that there is a long-run relationship between education expenditure and real GDP Per Capita, while the latter is also affected in the long run by changes in higher education. Short run causality result showed a unidirectional causal relationship between education expenditure and GDP per capita, running from education expenditure to GDP per capita. On the other hand, GDP per capita is found to have a unidirectional causal relationship with higher education, running from GDP per capita to higher education. Impulse response function graphs showed the relationship between GDP per capita, higher education and expenditure on education last for long years provided that the government channels its education expenditure towards more productive expenditure such as research and development and training, establishment of more educational institutions particularly higher education and vocational training centres and procurement of adequate learning facilities that will lead to the economic growth of India.

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