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Human Capital and Economic Growth in India: A Co-integration and Causality Analysis

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Abstract

The aim of this study is to explore the causality relationship between the human capital investment (education & health investment) and economic growth of Indian economy using time series data running from 1991-92 to 2012-13. Co integration, Granger Causality analysis and Vector Error Correction Mechanism (VECM) has been used in order to test the hypotheses about the presence of causality and co integration among the variables. The co integration test confirmed that education investment, health investment and GDP are co integrated, indicating an existence of long run equilibrium relationship as confirmed by the Johansen co integration test results. The Granger causality test confirmed the presence of two way causality between education investment and GDP and also between health investment and GDP. It justify that both the components of human capital under consideration i.e. education investment and health investment are the key variables which are affecting economic growth of India and in the same way economic growth providing a platform for the growth of human capital.

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Introduction

Sustained economic growth accompanied with social development is one of the notable macroeconomic objectives of every country and in this regard human capital is deemed as an essential ingredient. The initial theory of human capital dates back to pioneer work of Mincer, Schultz and Becker who believe that human capital, is just like physical capital and one can invest in it by means of education, health and training which, in turn, will raise output and contribute to economic growth. Furthermore, proponents of endogenous growth theory lay emphasis on human capital formation and regard it a factor which explains difference in growth performance of under developed and developed nations (for details, see, Romer, 1986; Lucas, 1988; Rebelo, 1991). Therefore, it can be concluded that human capital has gained significant importance in growth theories. Human capital theory suggests that individuals and society derive economic benefits from investments in people (Sweetland, 1996). Education has consistently been emerged as the prime human capital but Becker (1993) and Schultz (1997) have argued that health and nutritional expenditure is also a part of human capital investment. This is because education is perceived to contribute to health and nutritional improvements. Education, health, nutrition, water and sanitation complement each other, with investments in any one contributing to better outcomes in the others (World Health Organisation [WHO], 2001). Modern theory of economic growth argues that human capital investment, especially education and health investment has the principal role on achieving economic growth and development (Brempong &Wilson, 2004). The concept of human capital refers to the abilities and skills of human resources of a country, while human capital formation refers to the process of acquiring and increasing the number of people who have the skills, good health, education and experience that are necessary for economic growth. Thus, investment in education and health are considered as human capital development.

It is commonly believed that economic growth leads population to live better, have longer lives and good health. Firstly, economic growth means rising per capita income and part of this increased income is translated into the consumption of higher quantity and better quality nutrients. Through nutrition, health as measured by life expectancy responds to increases in income (Rosenzweig, Stark & Fogel, 1997). Secondly, economic growth is fuelled by technological progress and part of this progress is reflected in improvements in medical science (Rosen, 1993). The state of health in a country affects its economic growth through various channels. When health improves, the country can produce more output with any given combination of skills, physical capital and technological knowledge. One way to think about this effect is to treat health as another component of human capital incorporated in formulating the endogenous growth models (Thomas & Strauss, 1997, Bloom et al., 2001). The effects of human capital variables (namely, health and education) imply that the investment rate tends to increase as levels of education and socio-economic status of health rise. Longer life expectancy encourages larger investments in human capital, which in turn accelerates the per capita income. The other most important component of human capital development i.e. investment in education also contributes to economic growth directly and indirectly. The indirect effect of education on economic growth is measured through productivity improvement. The productivity of labor is influenced by the investment in human capital. This line of thought has not only caused reawakening of the field of endogenous growth but has also established the significance of human resource development through the spillover benefits of education in achieving fast economic growth in many countries including the countries in Asia and Africa (McMahon, 1998; Brempong &Wilson, 2004). Using the time series data, Haldar (2009) has observed that among the three growth models (viz. physical capital, human capital and export led growth), the human capital accumulation led growth model is more relevant to Indian economy. The present research study tries to examine the casual relation between human capital investment (education & health investment) and economic growth in Indian economy using time series data running from 1991-92 to 2012-13. The proper understanding of the relationship between human capital investment and economic growth enables policy makers to formulate and implement proper policies that may help in utilizing the human resources of the country properly.

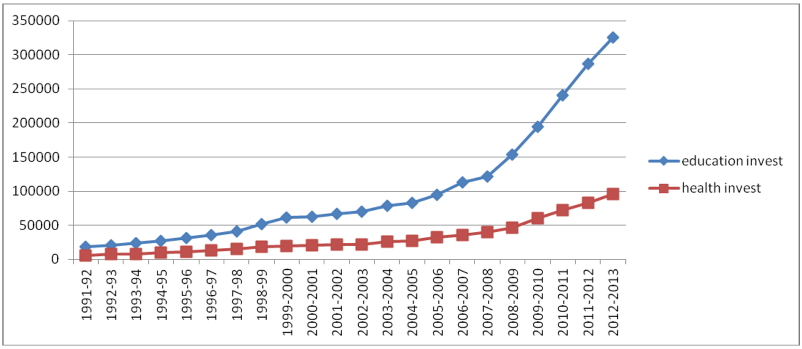

Fig 1: Trends in Education & Health Investment in India (1991-92 to 2012-13)

Source: Indian Public Finance Statistics(2013) & Author's Calculation

The above figure (1) shows that both the variables i.e. education and health investment has been rising continuously from 1991-92 to 2012-13 but the investment in education has been rising at a faster rate than the health investment which is a good indicator of economic prosperity. The paper has been divided into four sections. Section-I gives a brief summary of review of literature. Econometric Methodological issues have been discussed in section-II. The empirical results and their discussion have been given in section-III. The main conclusions emerging out of the study and policy implications have been discussed in section-IV.

Review of Literature

Many theoretical and empirical studies have been undertaken to establish the relation between human capital investment and economic growth. The prominent among them are:

Ansari and Singh (1997) use annual time series data from 1951 to 1987 to study the relationship between public spending on education and growth. They found that there is no long run relationship between the two.

Barro and Sala-i-Martin (1995; 2004) also tried to prove the effect of primary, secondary, and tertiary school attainment (by sex) on economic growth. They got an insignificant effect of primary education of males and females on economic growth. But they found significant relationship for males' secondary and tertiary education. They also analyzed the role of educational attainment on the convergence theory. Their result proves that countries with relatively low initial GDP grow faster when they have higher levels of human capital in the form of educational attainment.

Pradhan (2009) investigates the causality between public education spending and economic growth in India during 1951 to 2001. The empirical investigation has been carried out by Error Correction Modeling. The findings suggest that there is unidirectional causality between education and economic growth in the Indian economy. The direction of causality is from economic growth to education spending and not vice versa.

Malik (2006) using OLS fails to find positive association between human capital and economic growth in Pakistan and when he uses 2SLS estimation technique the results are totally opposite.

Chandra (2010) has tested for a causal relationship between education investments and economic growth for India for the time period 1951-2009 using linear and non-linear Granger causality methods. He found that there is bidirectional causality between education spending and GDP for India. Thus, it can be seen that overall, the empirical evidence regarding this relationship for India too is quite mixed.

Qadri and Waheed (2011) investigate the impact of human capital on Pakistan's economic growth during 1978-2007 and find it a highly significant determinant of economic growth. They utilize health adjusted education indicator as a proxy for human capital in Cobb-Douglas production function rather defining human capital solely in terms of health or education.

Khatak and Khan (2012) use analytical techniques, *i.e.* OLS and Johansen co integration to investigate the impact of human capital in economic growth of Pakistan for the period 1971-2008. The results support significant positive association between secondary education and economic growth.

Econometric Specification

The present research study aims to test the empirical relation between education investment, health investment and economic growth of Indian economy using the natural logarithms of variables for the time period 1991-92 to 2012-13. The data used in the study is secondary and have been collected from Ministry of education, Ministry of Public Finance Statistics, Economic Survey etc. Given the nature of problem and quantum of data we first study the data properties form an econometric perspective starting with the stationary of data. We employ co integration technique and Error Correction Model to investigate the causality between education, health and economic growth (GDP).

Hypothesis of the Study

The present paper is based on the following hypotheses for testing the causality and co integration between education investment, health investment and economic growth (GDP) in India:-

1. Is there a causal relationship between human capital investment and economic growth in India?

2. Does human capital investment (education & health investment) have a significant long-run and short-run impact on economic growth of Indian economy for the time period 1991-92 to 2012-13?

Stationary and Order of Integration

In order to avoid spurious regression, we need to distinguish the stationary of the series. By doing so, we ensure the validity of the usual test statistics (t-statistics and F-statistics and R2). Stationary could be achieved by appropriate differencing and this appropriate number of differencing is called order of integration. The standard Augmented Dickey Fuller [ADF] (Dickey and Fuller 1979) Unit root tests and Phillips Perron test have been used to check the stationary of the series.

Augmented Dicky Fuller Test

The Augmented Dickey Fuller (ADF) test is preferred as most of the studies have adopted it to examine the Unit root in the series FDI and GDP. In case of Dickey-Fuller test, there may create a problem of Autocorrelation. To tackle the problem of Autocorrelation problem, Dickey Fuller has developed a test called Augmented Dickey Fuller (ADF) test.

1. With Constant (Intercept):-
   $\Delta Y_t = \beta_1 + \delta Y_{t-1} + \Sigma \alpha_i Y_{t-1} + e_t$
2. With Constant and Trend:-
   $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \Sigma \alpha_i Y_{t-1} + e_t$
3. Without Constant and Trend:-
   $\Delta Y_t = \delta Y_{t-1} + \Sigma \alpha_i Y_{t-1} + e_t$

Hypothesis

Null Hypothesis ⇒Ho: $\delta = 0$ (Series is not stationary or got unit root)

Alternative Hypothesis ⇒H1: $\delta \neq 0$ (Series is stationary or no unit root problem).

If the computed absolute value of the tau statistics (τ) exceeds the ADF or Mackinnon critical values, we reject the hypothesis that $\delta = 0$, in which case the time series is stationary. On the other hand, if computed absolute value of the tau statistics (τ) does not exceed the critical tau value, we do not reject the null hypothesis, in which case the time series is non-stationary. The augmented Dickey-Fuller test is based on the assumption that the errors are statistically independent and have a constant variance. While relaxing these assumptions we can use an alternative test namely Phillips-Perron test.

Phillips Perron Test

This test allows the disturbances to be weakly dependent and heterogeneously distributed. To explain this procedure considers the following regression equations:

$yt = \alpha^* + \beta^* yt\text{-}1 + \mu t$ and

$$yt = \alpha 0 + \beta 0\ yt\text{-}1 + \gamma 0(t\text{-}T/2) + \mu t$$

Where T= number of observations and the disturbance term μt is such that E (μt) =0, but there is no requirement that the disturbance term is serially uncorrelated or homogeneous. Phillips-Perron characterize the distribution and derive test statistics that can be used to test hypotheses about the coefficients α^*, β^*, $\alpha 0$, $\beta 0$ and $\gamma 0$ under the null hypothesis that the data are generated by $yt = yt\text{-}1 + \mu t$. Thus the Phillips-Peron test statistics are modifications of the Dickey-Fuller t-statistics that take into account the less restrictive nature of the error process. If the two time sequences are all integrated of order one i.e., I (1) either following the augmented Dickey-Fuller test or the Phillips-Perron test we can perform co-integration test with them.

Co-integration Test

Once the unit roots are confirmed for data series, the next step is to examine whether there exists a long-run equilibrium relationship among the variables. This calls for co integration analysis which is significant so as to avoid the risk of spurious regression. Co integration analysis is important because if two non-stationary variables are co integrated, a VAR model in the first difference is mis specified due to the effect of a common tend. If a co integration relationship is identified, the model should include residuals from the vectors (lagged one period) in the dynamic Vector Error Correcting Mechanism (VECM) system. In this stage, the Johansen (1988) co integration test is used to identify a co integrating relationship among the variables. In this study, Johansen test was used to assess the co integration of the interest variables. We have applied two maximum likelihood tests, the Trace test and Maximum Eigen value tests, advocated by Johansen (1988) and Johansen and Juselius (1990).

Vector Error Correction Model (VECM)

Once the co integration is confirmed to exist between variables, then the third step entails the construction of error correction mechanism to model dynamic relationship. The Purpose of the error correction model is to indicate the speed of adjustment from the short run equilibrium to the long-run equilibrium state. A Vector Error Correction Model (VECM) is a restricted VAR designed for use with non-stationary series that are known to be co integrated. Once the equilibrium conditions are imposed, the VECM describes how the examined model is adjusting in each time period towards its long-run equilibrium state. Since the variables are supposed to be co integrated, then in the short-run, deviations from this long-run equilibrium will feedback on the changes in the dependent variables in order to force their movements towards the long-run equilibrium state. Hence, the co integrated vectors from which the error correction terms are derived are each indicating an independent direction where a stable meaningful long-run equilibrium state exists. The VECM has co integration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge on their co integrating relationship while allowing for short-run adjustment dynamics. The co integration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. The dynamic specification of the VECM allows the deletion of the insignificant variables, while the error correction term is retained. The size of the error correction term indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium state. The error correction term represents the long-run relationship. A negative and significant coefficient of the error correction term indicates the presence of long-run causal relationship.

Granger – Causality Test

This test is based on the Granger (1969) approach to the question of whether X causes Y. Granger proposed to know how much of the current value of Y can be explained by the past values of Y and then to find out whether adding lagged values of X can improve the explanation. The direction of causality determines the direction of the relationship among variables and Granger causality test has three different directions for these purposes: In case of one way causality, in a single equation model, Y is the dependent variable and X independent. Here, there is a causality relationship from X towards Y (X □Y). Independent variable is the cause and causes a one-way effect on dependent variable, which shows the presence of one-way causality and the relationship is determined as (Y X), whereas in two-way causality, there can be a reciprocal effect between the variables. If there is no relationship among variables, this implies the absence of causality. Granger's causality test is carried out by using the following equations:-

$$Y_t = \sum_{i=1}^{m} \alpha_i Y_{t-1} + \sum_{J=1}^{m} \beta_j X_{t-j} + u_{1t} \quad (1)$$

$$X_t = \sum_{i=1}^{m} \lambda_i X_{t-1} + \sum_{J=1}^{m} \delta_j Y_{t-j} + u_{2t} \quad (2)$$

The above equation (1) shows a causality relationship from X to Y, and the equation (2) from Y to X. For the model presented above, Granger causality test is carried out as

H0: B= 0 and H1: B ≠ 0. When H0 hypothesis is accepted, X is not the cause of Y. If H1 hypothesis is accepted X is the cause of Y. If both hypotheses are rejected, this means there is a two-way causality between X and Y.

Empirical Results and Discussion

The objective of this study is to empirically validate the role of human capital investment in increasing economic growth of Indian economy. Given the nature of problem and quantum of data we first study the data properties form an econometric perspective starting with the stationary of data. We employ co integration technique to investigate the causality between Education, Health and Economic Growth (GDP). If the variables are found to be integrated of same order, only then we can apply the co integration analysis. Before we apply co integration test, we check that series are non stationary. Hence, we have done stationary test on the sample series, the results of stationary test are given in the following table 1

Table: 1 Augmented Dicky Fuller Test

Variables	With nConstant	With Constant & Trend
Economic Growth (GDP)	-4.653735**	-4.508354**
Critical Values		
5% level	-3.029970	-3.673616
10% level	-2.655194	-3.277364
Education	-3.021692**	-3.032540**
Critical Values		
5% level	-3.020686	-3.658446
10% level	-2.650413	-3.268973
Health	-3.520392**	-3.511722**
Critical Values		
5% level	-3.020686	-3.658446
10% level	-2.650413	-3.268973

*&** denotes significance at 5% and 10% level of significance. The lag length was determined using Schwartz Information Criteria (SIC)

The above table (1) shows that series belonging to GDP, education and health is not stationary in level value. It becomes stationary only when first difference is taken. The table further reveals that as the calculated ADF statistics exceed the tabulated critical values at 5% and 10% level of significance, therefore we reject the null hypothesis of unit root and non-stationary and conclude that variables are stationary only at the first difference. Strong evidence emerges that all the time series are I (I) at the 5% and 10% Level of significance.

Table: 2 Phillips Perron Test

Variables	With Constant	With Constant & Trend
Economic Growth GDP)	-4.653735**	-4.508598**
Critical Values		
5% level	-3.029970	-3.673616
10% level	-2.655194	-3.277364
Education	-3.021692**	3.032540**

Variables	With Constant	With Constant & Trend
Critical Values		
5% level	-3.020686	-3.658446
10% level	-2.650413	-3.268973
Health	-3.578094**	-3.557119**
Critical Values		
5% level	-3.020686	-3.658446
10% level	-2.650413	-3.268973

*&** denotes significance at 5% and 10% level of significance

The Philips Perron (PP) results as shown in the above table (2) indicate that the results obtained by Augmented Dickey Fuller (ADF) test confirm to the PP test results. Hence the null hypothesis of a unit root is rejected and we conclude that all the variables are stationary at first difference integrated of same order I (I). To employ co integration technique it is a pre condition that the series have to be non stationary which is met. Hence we employ co integration technique to determine the existence of stable long run relationship between GDP, education and health in India for the period 1991-92 to 2012-13. The co integration results are reported in Table 3. Results of co integration are obtained using VAR lag length order selection criterion.

Table:-3 Johansen Co-integration Test Results

Hypothesized Number of Co integrating Equations	Eigen Value	Trace Statistics	Critical Value at 5% (p-value)	Maximum Eigen statistics	Critical Value at 5% (p-value)
None*	0.819146	42.07988	29.79707 (0.0012)	32.49120	21.13162 (0.0008)
At Most 1	0.395853	9.588674	15.49471 (0.3137)	9.574812	14.26460 (0.2414)
At Most 2	0.000729	0.013862	3.841466 (0.9061)	0.013862	3.841466 (0.9061)

Source: Author's own Calculation

* denotes rejection of the hypothesis at the 0.05 level

The above table (3) shows that first hypothesis i.e. no co integration among variables can be rejected as p-value (0.01%) is less than the critical value (29.79%) at 5% level of significance on the basis of trace statistics. The second null hypothesis i.e. there is at least one co integrating equation can't be rejected because p-value (31.37%) is more than the critical vale (15.49%) at 5% level of significance, rather we accept this null hypothesis i.e. there is at least one co integrating equations. This implies that our three variables GDP, education and health are co integrated i.e. all the variables have long run association among them. And the Maximum Eigen test statistics makes the confirmation of this result. After analyzing that there is significant co integration in the sample series we employ Granger causality test to know the causality between the two variables. Granger causality is a statistical concept of causality that is based on prediction. The results of Pair-wise Granger causality test done for 2 Time lags between the two variables for which unit root test is carried out are shown in the following table (4):-

Table:-4 Granger Causality for the Period 1991-92 to 2012-13

Pair wise Granger Causality Tests			
Sample: 1991-92 TO 2012-13			
Lags 2			
Null Hypothesis	F-statistics	Probability	Decision
Education Investment does not Granger Cause GDP	6.94212*	0.0073	Reject
GDP does not Granger Cause Education Investment	5.63211*	0.0150	Reject
Health Investment does not Granger Cause GDP	17.2079*	0.0001	Reject
GDP does not Granger Cause Health Investment	6.28999*	0.0104	Reject

The results exhibited in Table 4 confirm the two way causality between education investment and GDP with p-value < 0.05 in both the cases which signifies rejection of null hypothesis. Hence the test results confirm two way causality between the two variables namely education investment and GDP. The second hypothesis i.e. health investment doesn't granger cause GDP and GDP doesn't Granger cause health investment can also be rejected as the p-value is found to be less than 5% level of significance. The results further indicate that there is two way causality between health investment and GDP.

Error Correction Mechanism

The coefficients of Error Correction Term (ECM) contain information about whether the past values affect the current values of the variable under study. A significant coefficient implies that past equilibrium errors play a role in determining the current outcomes. The information obtained from the ECM is related to the speed of adjustment of the system towards long-run equilibrium. The short-run dynamics are captured through the individual coefficients of the difference terms. The results of VECM analysis are given in the following table 5:-

Table:-5 Estimates For VECM Regression

Dependent Variable: D(GDP) Method: Least Squares ; Sample (adjusted): 1994 2012 Included observations: 19 after adjustments				
D(GDP) = C(1)*(GDP(-1) + 0.773949611149*EDU(-1) - 1.87621675891 *Health(-1) - 4.44265466174) + C(2)*D(GDP(-1)) + C(3)*D(GDP(-2)) + C(4)*D(EDU(-1)) + C(5)*D(EDU (-2)) + C(6)*D(HEALTH(-1)) + C(7) *D(Health(-2)) + C(8)				
	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	-0.386111	0.099709	3.872394*	0.0026
C(2)	-0.238391	0.290129	-0.821671	0.4287
C(3)	-0.057126	0.211733	-0.269802	0.7923
C(4)	-0.426517	0.109808	-3.884213*	0.0025
C(5)	-0.159419	0.101563	-1.569662	0.1448
C(6)	0.848221	0.167305	5.069912*	0.0004
C(7)	0.434704	0.141669	3.068454*	0.0107
C(8)	0.083433	0.021007	3.971666*	0.0022
R-squared	0.841651	Mean dependent var		0.128459
Adjusted R-squared	0.740883	S.D. dependent var		0.029114
S.E. of regression	0.014820	Akaike info criterion		-5.290131
Sum squared resid	0.002416	Schwarz criterion		-4.892473
Log likelihood	58.25625	Hannan-Quinn criter.		-5.222832
F-statistic	8.352376	Durbin-Watson stat		2.210887
Prob(F-statistic)	0.001167			

The above table (5) shows that the estimated error correction term has negative sign and is statistically significant at 5 per cent level of significance which confirms that there can be long run equilibrium relation between dependent and independent variables. The value of R2 is also found to be high i.e. 0.84 and F-value is also found to be statistically significant at 5% level of significance which shows that the overall model is significant. The individual coefficients are found to be statistically significant which indicate the presence of short-run causality running education investment and health investment to GDP. In order to check the short-run causality running from education investment to GDP and health investment to GDP, we have also applied Wald test:-

H0:- C(4)=C(5)=0

H1:- C(4)=C(5) ≠0

H0:- C(6)=C(7)=0

H1:- C(6)=C(7) ≠0

Table:-6 Short Run Causality (Wald Test)

Hypothesis	Chi-Square	P-Value	Decision at 5% Level of Significance
H_0 = GDP doesn't Granger Cause Education investment	15.39552	0.0005*	Reject H_o
H_0 = GDP doesn't Granger Cause Health investment	26.45658	0.0000*	Reject H_o

Source: Author's calculation

The above table (6) clearly indicates that there is presence of short run causality running from education investment to GDP and health investment to GDP as p-value is found to be less than 5% level of significance in both the cases. If p-value is found to be less than 5% level we can reject the null hypothesis which means that there is existence of short run causality between the two variables.

Conclusions

The present paper tries to empirically explore the relationship between human capital investment (education & Health investment) and economic growth (GDP) of India using annual data over the period 1991-92 to 2012-13. We found that investment in education and health are very important and has a significant positive long run effect on per capita GNP growth. Good health and nutrition enhance workers' productivity. Healthier people who live longer have stronger incentives to invest in developing their skills, which increases workforce productivity by increasing work capacity and efficiency of workers in the same way educated people can efficiently cop up with the new technology and with the outer world, that will stimulate economic condition of economy and healthier educated person can be treated as an asset for an economy.

Co integration test confirmed that education investment, health investment and GDP are co integrated, indicating an existence of long run equilibrium relationship among the three variables. It implies that investment in human capital i.e. on education and health has definitely long run impact on growth. The error correction estimates gave evidence that the Error-Correction Term (ECT) is statistically significant and has a negative sign, which confirms that there is long-run equilibrium relationship between these variables. The wald test clearly indicates the presence of short run causality running from education investment to GDP and health investment to GDP. The pair-wise Granger causality test confirmed the presence of two-way causality between GDP and variables of human capital. It Justify that both the components of human capital under consideration i.e. education investment and health investment are the key variables which are affecting economic growth of India and in the same way economic growth providing a platform for the growth of human capital.

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