# NEXUS BETWEEN GROWTH AND HUMAN DEVELOPMENT INDEX: EVIDENCE FROM INDIA AND INDIAN STATES

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***Abstract:*** *In this paper, the author endeavors to show the nature of HDI and the relation between HDI of India and economic growth, rate of unemployment, GDP and GDP per capita respectively during 1990-2016. The author used semi log and double log regression model and also used Bai-Perron Model (2003) for structural breaks, Granger model (1969) for causality, Johansen model (1988,1996) for cointegration and vector error correction and Sala-i-Martin(1996) model for convergence test in Indian States. The paper concludes that HDI of India has been increasing at the rate of 1.55% per year from 1990 to 2016.HDI has three upward structural breaks in 1996, 2004 and 2011 respectively. HDI of India does not follow random walk hypothesis. One per cent increase in HDI of India led to 1.41% increase in growth rate per year during 1990-2016. This relationship is co-integrated and they have no bidirectional causality. Their VECM is unstable and non-stationary and error correction is significant and fast for equation Δlog(GDP growth rate). Moreover, one per cent rise in HDI per year led to 5.86% rise in GDP, 4.828 % increase in GDP per capita and 0.5028% decrease in unemployment rate per year respectively during 1990-2016 in India. There is positive association between HDI, GSDP and GSDP per capita of all states in 1983, 1987-88, 1999-00, 2004-05, 2009-10 and 2011-12. These relationships are valid for high plus medium human development and low human development states of India for those years. In Fixed effect model of panel data, the regression between of all states' HDI and GSDP per capita is positive. This paper finds sigma convergence of HDI of all states. Only four states showed negative growth of HDI in spite of their rising trends of social sector expenditure. The paper recommended to enhance government expenditure on education and health and to emphasis gender budgeting and FDI inflows.*

***Key Words-****Human Development Index, Economic Growth, Cointegration, Causality, Vector Error Correction, HDI of Indian States*
***JEL Codes****-O10, O15, O57, C23*

## 1. INTRODUCTION

Economic thoughts on the recognition of human capital as central force in economic theory since long period were relevant when Adam Smith (1776) argued that growth means not only capital accumulation and technical progress but also growth of human capital which play a critical role in the progress of economic development. With obvious reason, Marshall (1890) stressed education and parental care as investment in human capital. Then Schultz (1963) in the human capital model showed how education allows the production process to benefit from positive externalities and promotes growth. Gary Becker (1964) said that human capital investment increases the ability of people to increase wealth because human capital is the investment in training, education, health, values and other aspect of human potential. After a decade, Lucas (1988) in the endogenous growth theory emphasized investment in human capital more directly and linked it to long term rates of economic growth. In internal growth models, Romer (1986; 1990), and later economists investigated economic growth through physical and human capital accumulation. Besides labor and capital, human capital had a significant place in endogenous growth models and additionally the effects of human capital on economic growth were pointed out in previous studies in the literature (Telatar & Terzi, 2010). In analyzing the process of human capital, Hahbub Ul Haq (1995) defined human development paradigm as “the process of enlarging people’s choices”. Amartya Sen (1999) went further and argued that standard of living of a society should be judged not by the average level of income but by people’s capabilities to lead the life they value. Author argued that development ought to be viewed as capability expansion and freedom, rather than being viewed as purely economic phenomenon. Additionally, Becker, Murpy, & Tamura (1990) in a study titled “Human Capital, Fertility and Economic Growth”, indicated higher returns of human capital and education in developed countries than in developing countries. Based upon the aforementioned information, one can see that the size of a population alone is not sufficiently effective on economic growth and the bottom line is the knowledge, skills, and experience-like attributes of the population.

Human development has positive impact on economic growth through improvement of human capital because education has strong effects on labour productivity and improvement in health and nutrition enhances productivity and income. More educated people are likely to innovate and thus affect everyone’s productivity. Even, education may affect per capita income growth through reducing population growth. Distribution of income and assets has an effect on economic growth because of better nutrition and strong demand for education and hence higher productivity. Education alone, of course, cannot transform an economy. The quantity and quality of investment, domestic and foreign together constitute other important determinants of economic performance. Education and health may also have strong indirect impacts on economic growth through their effects on distribution of income and education even more so through its impact on health. Tailor et al (1999) expressed that in developing countries economic growth is needed for reducing poverty, providing access to basic social services, building of basic capabilities in the people and generating the resources required for human development. Economic growth is a necessary but not sufficient condition for the promotion of human development. Beyond quantity, it is the quality of growth that is crucial for human well-being. Growth that is jobless, ruthless, voiceless, rootless and futureless is not favorable to human development .Economic growth must be equitable for its benefits to have an impact on people’s lives. Human development and economic growth have two-way causal relationship. Human development raises levels of education, health, and nutrition in an economy all of which enhance productivity of the economy. And growth can also be linked to many other elements of human development such as political freedom, cultural heritage, societal progress and environmental sustainability. Because, modern growth theory explains economic growth rate primarily in terms of expanded human and social capital rather than physical capital. On the one hand, economic growth provides the resources to permit sustained improvement in human development. On the other hand, sustained improvement in the quality of human capital is an important contribution to economic growth.

## 2. Review of literature

There are huge economic literature and researches on the nexus between human development and economic growth. Author has reviewed some of the research papers in lucid manner. Ramirez, Ranis & Stewart(1997) found two way relationship studying cross country statistics from 1970-92 and suggested that both HDI and growth should be jointly promoted. Boozer, Ranis, Stewart & Sure(2003) explored the relation between human development and economic growth including their changes and found two way linkages during 1960-2001 for 87 countries of all over the world. Ljungberg & Nilsson (2009) carried out a study on the Swedish economy with data covering the period within 1870-2000 and investigated the relationship between human capital and economic growth with the Granger causality test. The researchers reported that human capital was a significant factor in the growth of the Swedish economy, but the effects of human capital with improved educational levels after the 1970s had relatively lower impacts on economic growth than expected. Mukherjee & Chakraborty (2010) relate HDI of states with per capita GSDP of urban and rural areas during 5 decades and found rural urban difference in Indian states and also found influence of HDI on per capita GSDP which varies state to state.

Sure, Boozer, Ranis & Stewart (2011) studied the two-way relationship between HDI and growth rate in India. They remind that early focus on HDI is necessary because its direct impact and feedback effect on sustaining economic growth. Khodabakshi (2011) examined that HDI of India is growing along with the downside. Growth index is decreasing from 2009 (0.012) to reach in 2010 (0.014).India's life expectancy is very ineffective. Gorica & Gemini (2013) found a low and significant positive impact of GDP per capita on HDI in Albania during 1990-2011. Deb (2015) examined rank differences between two points of HDI and per capita GDP during 1990, 2000, 2010, 2013, using Spearman rank correlation, Logit and Probit regression for 140 countries and found positive relation in low income countries and weak relation in middle and high income countries. Author also found high positive relation between HDI and GDP per capita. Grubaugh (2015) examined to study HDI during 1980-2010 of 83 countries with 13 variables and studied growth for 73 countries during 1960-2000 with 35 variables. Author estimated growth –HDI nexus and found significant positive relation for 55 developing countries assuming growth is dependent variable. Boztosun, Aksoylu, & Ulucak (2016) examined the relationship between human capital and economic growth and analyzed with cointegration and causality tests by using the data of Turkey for the period 1961-2011. Their findings revealed a dual causality relationship between human capital and economic growth variables.

## 3. Objective of the paper

In this paper, the author endeavors to show the patterns of India's human development index from 1990 to 2016. The relation between HDI of India with economic growth, rate of unemployment, GDP and GDP per capita respectively during the specified period were done through regression analysis. The paper studied the structural breaks of HDI and the causality between HDI, growth, unemployment and GDP respectively. Variance ratio test was done for HDI of India during 1990-2016 to show random walk. The co-integration and vector error correction among the aforesaid variables were tested for India. In studying relation of India's State HDI with GSDP and GSDP per capita ,author classified the states into two groups, low human development states and medium plus high human development states and fitted regression equations taking data for 1983,1987-88,1993,1999-2000,2004-05,2009-10 and 2011-12 respectively. Fixed effect panel regression model between HDI of Indian states and GSDP was shown during the above period. Besides, the normality of the HDI of all states in India during the same period was tested through Jarque-Bera statistic. Author is interested to verify sigma Convergence of HDI of all states in India through Sala-i-Martin hypothesis.

## 4. Methodology and data

The author used semi log and double log regression model to study trend of HDI and relation with growth, GDP, GDP per capita and unemployment rate of India during 1990-2016. Author also used Bai-Perron Model (2003) for structural breaks, Granger model (1969) for causality, Johansen model (1988, 1996) for cointegration and vector error correction and also applied variance ratio test for verifying random walk of HDI of India during 1990-2016.The double log regression technique was used to show relation between HDI and gross state domestic product per capita of all Indian States by fixed effect panel data regression model. This relationship was shown separately in high plus medium human development states and low human development states in India during 1983, 1987-88, 1993, 1999-00, 2004-05, 2009-10 and 2011-12 respectively. Jarque-Bera statistic was used to show the normality of HDI of all states in India. The sigma convergence was tested by the methodology of Sala-i-Martin (1996). The data of HDI of India was collected from www.unctad.org. The data of growth and unemployment rates of India were collected from the World Bank. The data of HDI and GSDP per capita of 27 Indian States were collected from Mukherjee, Chakraborty & Sikdar (2014).

### 4.1 Econometric Tests on HDI of India

### (A). Trends of HDI

Human Development Index of India has been increasing at the rate of 1.55% per year from 1990 to 2016 which is significant at 5% level. The estimated equation is shown below.

$Log(x_1)$=-0.872152+0.015596t

(-359.75)* (103.06)*

$R^2$=0.997 , F=10622.38* , DW=1.0187 , $x_1$= HDI of India , *=significant at 5% level.

It is a good fit except DW which clearly showed autocorrelation problem. The actual and fitted lines are plotted in Figure 1 where the fitted line is steadily rising upward.

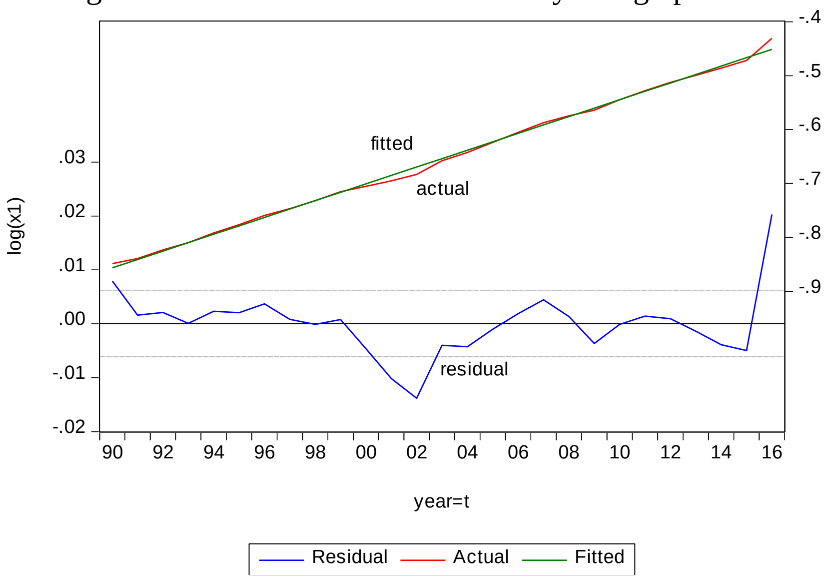


Figure 1:Trend line HDI of India

Source-Plotted by author

By applying Bai-Perron(2003) test we have got three upward structural breaks of HDI of India in 1996,2004 and 2011 assuming L+1 vs. L sequentially determined breaks which contain maximum five breaks with trimming 0.15 , Newey-West fixed bandwidth=3.0 in HAC standard errors and covariance. The estimated values of coefficients, their t values and probabilities are given in the Table1.

Table 1: Structural breaks of HDI

| Variable | Coefficient | Standard Error | T statistic | Probability |
|---|---|---|---|---|
| | | 1990-1995…..6obs | | |
| C | -0.814882 | 0.014664 | -55.5687 | 0.00 |
| | | 1996-2003…8obs | | |
| C | 0.711808 | 0.016746 | -42.5058 | 0.00 |
| | | 2004-2010…7obs | | |
| C | 0.591611 | 0.017674 | -33.47377 | 0.00 |
| | | 2011-2016…6obs | | |
| C | -0.487979 | 0.017115 | -28.5122 | 0.00 |

(Source-Calculated by author, $R^2$=0.938, F=116.34*, 1.32)

In Figure 2,structural breaks in 1996,2004 and 2011 are shown clearly in the estimated line where all breaks are upward.

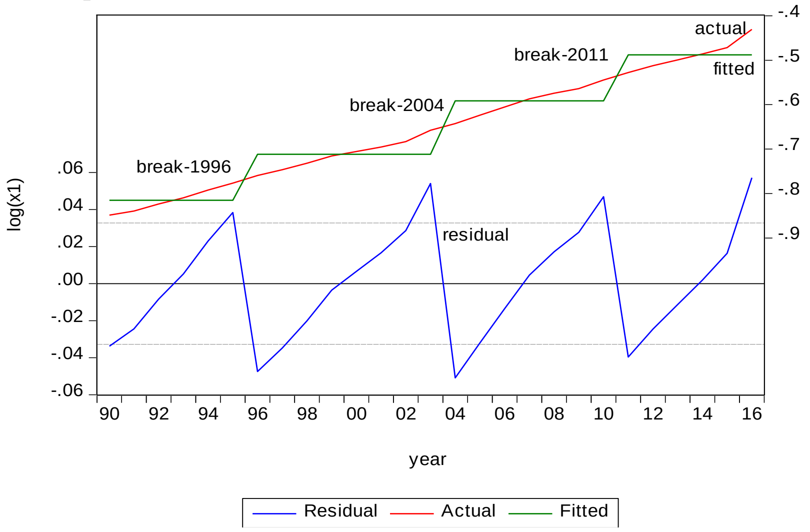


**Figure 2:Upward structural break of HDI**

Source-Plotted by author

Human Development Index of India from 1990 to 2016 does not follow random walk hypothesis because the probabilities of z statistic of joint and individual tests are greater than 5% probability in which the null hypothesis: HDI is a martingale is accepted. It is seen in Table 2.It means that India's HDI series is stationary.

**Table 2: Variance ratio test of HDI of India, 1990-2016**

| | | | | |
|---|---|---|---|---|
| Null Hypothesis: HDI is a martingale | Lags specified as grid: min=2, max=16, step=1,Obs=26 | | | |
| Joint Tests | Value | df | Probability | |
| Max \|z\| (at period 3) | 1.205616 | 26 | 0.9794 | |
| Individual Tests | | | | |
| Period | Var. Ratio | Std. Error | z-Statistic | Probability |
| 2 | 0.541651 | 0.500000 | -0.916698 | 0.3593 |
| 3 | 0.196256 | 0.666667 | -1.205616 | 0.2280 |
| 4 | 0.160574 | 0.750000 | -1.119235 | 0.2630 |
| 5 | 0.140694 | 0.800000 | -1.074132 | 0.2828 |
| 6 | 0.128969 | 0.833333 | -1.045237 | 0.2959 |
| 7 | 0.122180 | 0.857143 | -1.024123 | 0.3058 |
| 8 | 0.118787 | 0.875000 | -1.007101 | 0.3139 |
| 9 | 0.118011 | 0.888889 | -0.992237 | 0.3211 |
| 10 | 0.119487 | 0.900000 | -0.978348 | 0.3279 |
| 11 | 0.123107 | 0.909091 | -0.964582 | 0.3348 |
| 12 | 0.128972 | 0.916667 | -0.950213 | 0.3420 |
| 13 | 0.137365 | 0.923077 | -0.934521 | 0.3500 |
| 14 | 0.148810 | 0.928571 | -0.916666 | 0.3593 |
| 15 | 0.164141 | 0.933333 | -0.895564 | 0.3705 |
| 16 | 0.184658 | 0.937500 | -0.869698 | 0.3845 |

Source-Calculated by author

### [B] GDP Growth rate and HDI of India

It was found in India that there is a significant positive relation between HDI and GDP growth rate during 1990-2016. One per cent increase in HDI of India per year led to 0.0309 per cent rise per year in GDP growth rate of India which is insignificant at 5% level. The estimated regression equation is given below. The estimated equation faces very low $R^2$ with problem of autocorrelation.

$$\text{Log}(x_3) = 1.849878 + 0.03097\log(x_1)$$
$$(20.26)^* \quad (0.47)$$

$R^2=0.0089$, F=0.225, DW=1.70, *=significant at 5% level, $x_3$=GDP growth rate of India

In India, both the HDI and GDP growth rate do not influence each other and in other words, Granger-Causality Test (1969) suggests that there is no bi-directional causality between growth and HDI during 1990-2015. It is stated below in Table 3.

**Table 3: Granger-Causality test (lag-2) between HDI and GDP Growth**

| Null Hypothesis | Observations | F-Statistic | Probability |
|---|---|---|---|
| $X_3$ does not Granger Cause $x_1$ | 25 | 0.10863 | 0.8976 |
| $X_1$ does not Granger Cause $x_3$ | | 0.02859 | 0.9719 |

Source-Calculated by author

Johansen cointegration test between HDI and GDP growth rate in lag 1(assuming constant and trend in the stationary series) in India from 1990-2016 verified that Trace statistic and Max Eigen statistic have two cointegrating equations each that is shown in Table 4.

**Table 4: Cointegration test**

| Hypothesized no. of CEs | Eigen Value | Trace Statistic | 0.05 Critical Value | Probability** |
|---|---|---|---|---|
| None* | 0.641824 | 39.00486 | 25.87211 | 0.0007 |
| At most 1* | 0.413431 | 13.33662 | 12.51798 | 0.0364 |
| | | Max Eigen Statistic | | |
| None* | 0.641824 | 25.66825 | 19.38704 | 0.0053 |
| At most 1* | 0.413431 | 13.33662 | 12.51798 | 0.0364 |

*=denotes rejection of the hypothesis at 0.05 level, **=Mackinnon-Haug-Michelis (1999) p value

Source-Calculated by author

The estimated Vector Error Correction Model is given below because HDI and growth are cointegrated. The error correction of the equation $\Delta\log x_{3t}$ is significant where the speed of correction is 12244% per year and other coefficients are significant for $\Delta\log x_{1t-1}, \Delta x_{1t-2}, \Delta\log x_{3t-1}$. There is no short run or long run association between HDI and GDP growth rate.

$$\Delta\log x_{1t} = -74259.08 + 2894.93\Delta\log x_{1t-1} + 2894.846\Delta x_{1t-2} + 23.249\Delta\log x_{3t-1} + 11.749\Delta x_{3t-2} - 2896.047EC$$
$$(-1.25) \quad (1.25) \quad (1.25) \quad (1.15) \quad (0.74) \quad (-1.25)$$

$R^2=0.56$ , F=4.67,AIC=12.86,SC=13.15

$$\Delta\log x_{3t} = -3136.48 + 122.443\Delta\log x_{1t-1} + 122.441\Delta x_{1t-2} + 0.656\Delta\log x_{3t-1} + 0.205\Delta x_{3t-2} - 122.445EC$$
$$(-4.12)^* \quad (4.12)^* \quad (4.12)^* \quad (2.53)^* \quad (1.01) \quad (-4.12)^*$$

$R^2=0.60$ , F=5.53,AIC=4.15,SC=4.45 , *=significant at 5% level.

The cointegrating equation is found as, $x_{1t-1} = -26.08210 - 0.009364t + 0.013080x_{3t-1}$

$$(-17.46)^* \quad (4.96)^*$$

It is approaching towards equilibrium in the long run.

VECM is unstable since all roots (1.0, -5.290304 ± 8.779878i, -0.141710 ± 0.574526i ,9.847587) do not lie inside the unit circle. It is non-stationary since it has unit root.

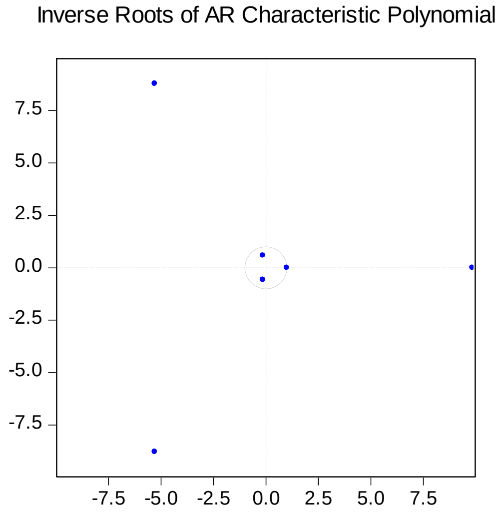


**Figure3: Stability of VECM**

Source-Plotted by author

But the VECM is nonstationary because the impulse response functions are diverging from zero due to shocks except growth to growth and HDI to growth.

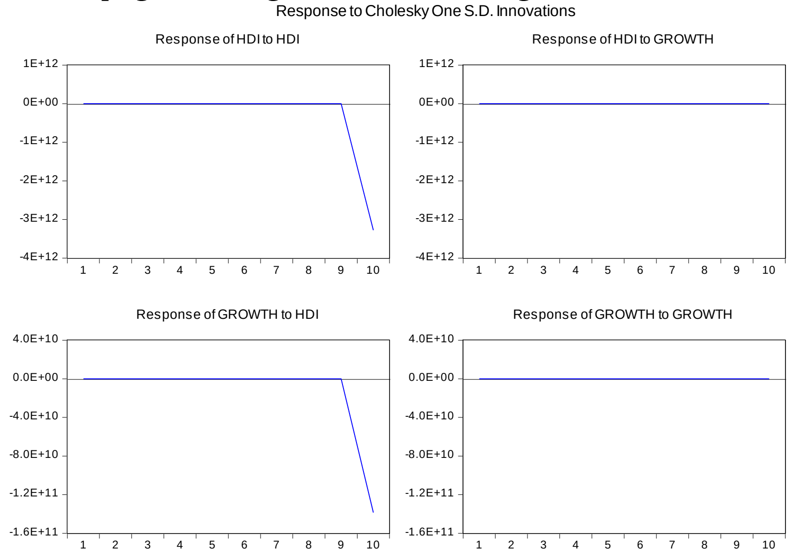


**Figure 4:Impulse Response Functions**

Source-Plotted by author

Residual test confirms that the model suffers from autocorrelation problem which is plotted in Figure 5.

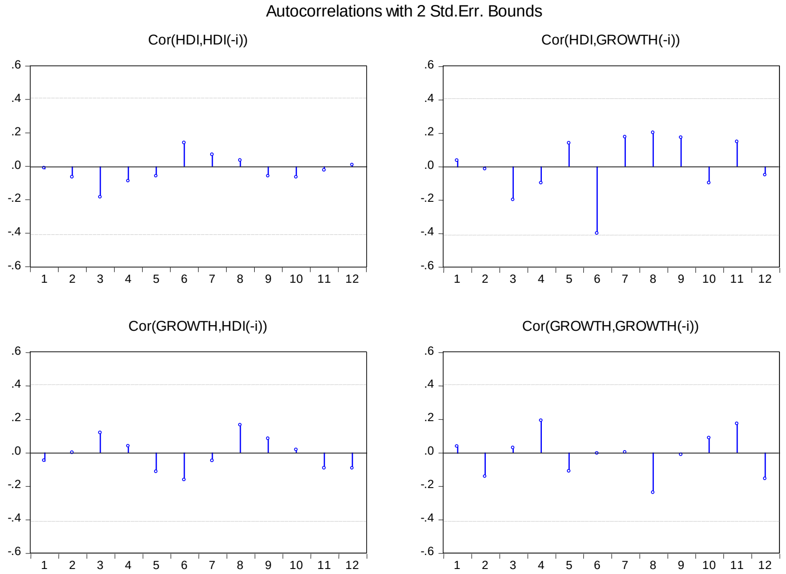


**Figure 5: Autocorrelation problem**

Source-Plotted by author

From the estimated VECM equation,it was found from the system equation that there is long run equilibrium of the cointegrating equation but it is insignificant.

[1]$\Delta x_{1t}$=-2896.047$x_{3t-1}$+0.01308$x_{1t-1}$-0.00936t-26.0821
(-1.25)

The estimated system equation is found as:

$\Delta x_{1t}$=-2896.047$x_{3t-1}$+0.01308$x_{1t-1}$-0.00936t-26.0821+2894.930$\Delta x_{1t-1}$+2894.846$\Delta x_{1t-2}$+23.24913$\Delta x_{3t-1}$
(-1.25) (1.25) (1.25) (1.15)

+11.74906$\Delta x_{3t-2}$-74159.08
(0.74) (-1.25)

$R^2$=0.56,F=4.67*,AIC=12.86,SC=13.156

If c(2)=c(3)=0,then Wald test(1943) showed that Chi-square(2)=1.613485 whose prob=0.4463, so there is insignificant short run causality running from HDI to HDI. If c (4) =c (5) =0, then Wald test showed that Chi-square (2) =1.34394 whose prob=0.51, so there is insignificant short run causality running from growth to HDI.

From the estimated VECM equation,it was found from the system equation that there is long run equilibrium of the cointegrating equation and it is significant.

[2]$\Delta x_{3t}$=-122.445$x_{1t-1}$+0.01308$x_{3t-1}$-0.00936t-26.0821
(-4.12)*

The estimated system equation is found as:

$\Delta x_{3t}$=-2896.047$x_{3t-1}$+0.01308$x_{3t-1}$-0.00936t-26.0821+122.44$\Delta x_{1t-1}$+122.4431$\Delta x_{1t-2}$+0.6563$\Delta x_{3t-1}$
(-4.12)* (4.12)* (4.12)* (2.53)*

+0.2055$\Delta x_{3t-2}$-3136.484
(1.01) (-4.12)*

$R^2$=0.605,F=5.53*,AIC=4.15,SC=4.45

If c (8) =c (9) =0, then Wald test showed that Chi-square (2) =17.092 whose prob=0.002, so there is no short run causality running from HDI to growth. If c(10)=c(11)=0,then Wald test showed that Chi-square(2)=7.650 whose prob=0.0218,so there is no short run causality running from growth to growth.

**[C] Unemployment rate and HDI of India**

HDI of India showed negative impact of unemployment rate and GDP growth rate during 1990-2016.If the HDI of India steps up by one per cent per year then unemployment rate declines by 0.0179 per cent per year.This result is insignificant at 5% level.It is not a good fit with low$R^2$ and autocorrelation.

$Log(x_2)=1.368149-0.017911log(x_1)$

(82.88)* (-1.519)

$R^2$=0.084,F=2.308 ,DW=0.95, $x_2$=unemployment rate of India , *=significant at 5% level.

HDI and unemployment rate of India during 1990-2016 showed no bidirectional causality as has been verified by Granger Causality test in lag 2. It is seen in Table 5.

**Table 5: Granger Causality test between HDI and unemployment rate**

| Null Hypothesis | Observation | F Statistic | Probability |
|---|---|---|---|
| $X_2$ does not Granger Cause $x_1$ | 25 | 1.61784 | 0.2232 |
| $X_1$ does not Granger Cause $x_2$ | | 0.48965 | 0.6200 |

Source-Calculated by author

Even, there is no cointegration between HDI and unemployment rate of India from 1990 to 2016 as has been verified by Johansen cointegration unrestricted rank test with lag 1 in Trace and Max Eigen statistic which showed no co-integrating equations which are given in Table 6.

**Table 6:Co-integration between HDI and unemployment rate**

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None | 0.483525 | 23.25652 | 25.87211 | 0.1023 |
| At most 1 | 0.236264 | 6.738313 | 12.51798 | 0.3726 |
| | | Max-Eigen Statistic | | |
| None | 0.483525 | 16.51820 | 19.38704 | 0.1244 |
| At most 1 | 0.236264 | 6.738313 | 12.51798 | 0.3726 |

* denotes rejection of the hypothesis at the 0.05 level

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

Source-Calculated by author

**[D] GDP and HDI of India**

If one percent rises in human development index of India per year during 1990-2016 then India's GDP will increase by 0.195 per cent per year significantly. The estimated regression equation is given below. It suffers from autocorrelation problem with low $R^2$.

$Log(x_4) =6.659152+0.195311log(x_1)$

(47.33)* (1.94)*

$R^2$=0.13, F=3.779*, DW=0.308, $x_4$= GDP of India, *=significant at 6% level.

HDI and GDP of India during 1990-2016 confirm unidirectional causality as has been verified by Granger Causality test in lag 2 or in other words, GDP of India does Granger causes human development index of India. It is seen in Table 7.

**Table 7: Granger Causality test between HDI and GDP**

| Null Hypothesis | Observation | F Statistic | Probability |
|---|---|---|---|
| $X_4$ does not Granger Cause $x_1$ | 25 | 4.21338 | 0.0297 |
| $X_1$ does not Granger Cause $x_4$ | | 0.69458 | 0.5109 |

Source-Calculated by author

**[E] GDP per capita and HDI of India**

Similarly, HDI and GDP per capita have positive relation in India where one per cent increase in HDI per year from 1990 to 2016 will rise 0.163 per cent in GDP per capita per year .This is significant at 6% level. We have estimated the regression equation below. The equation also faces autocorrelation problem with low $R^2$.

$$\text{Log}(x_5) = 6.555215 + 0.163190\log(x_1)$$
$$(56.16)^* \quad (1.957)^*$$

$R^2$=0.132, F=3.833*, DW=0.315, $x_5$= GDP per capita of India, *=significant at 6% level.

Granger Causality test in lag 2 between GDP per capita and HDI of India verified unidirectional causality which implies that GDP per capita does Granger Causes HDI of India during 1990-2016 but opposite is not true.

**Table 8: Granger Causality between GDP per capita and HDI (lag-2)**

| Null Hypothesis | Observations | F-Statistic | Probability |
|---|---|---|---|
| $X_5$ does not Granger Cause $x_1$ | 25 | 3.84686 | 0.0386 |
| $X_1$ does not Granger Cause $x_5$ | | 0.57977 | 0.5692 |

Source-Calculated by author

**(F). HDI-Across the Indian States**

**[1]** The distribution of HDI of all Indian States from 1983 to 2011-12 are normal except in Tamil Nadu because probability of Jarque-Bera statistic are greater than 5% level but they are volatile because coefficient of variation ranges from 10% to 60% .

**Table 9: Normality of HDI of all states**

| Indian States | Jacque -Bear | Probability | Distribution | Coefficient of variation% |
|---|---|---|---|---|
| Kerala | 0.449 | 0.798 | normal | 11.46 |
| Goa | 1.91 | 0.38 | normal | 12.79 |
| Punjab | 0.669 | 0.715 | normal | 10.14 |
| Himachal Pradesh | 0.861 | 0.649 | normal | 15.405 |
| Mizoram | 0.588 | 0.745 | normal | 14.86 |
| Maharashtra | 0.557 | 0.756 | normal | 15.7 |
| Gujarat | 0.508 | 0.775 | normal | 16.96 |
| Haryana | 0.670 | 0.715 | normal | 12.53 |
| J&K | 0.808 | 0.667 | normal | 19.22 |
| Karnataka | 0.632 | 0.728 | normal | 12.35 |
| Tamil Nadu | 6.23 | 0.04 | not normal | 263.54 |
| West Bengal | 0.693 | 0.706 | normal | 16.77 |
| Manipur | 0.469 | 0.790 | normal | 15.9 |
| Meghalaya | 0.106 | 0.948 | normal | 27.09 |
| Sikkim | 0.447 | 0.779 | normal | 28.9 |
| Odessa | 0.812 | 0.666 | normal | 23.48 |
| Rajasthan | 0.517 | 0.772 | normal | 26.82 |
| Madhya Pradesh | 0.837 | 0.657 | normal | 35.15 |
| Arunachal | 0.294 | 0.863 | normal | 38.64 |
| Uttar Pradesh | 0.640 | 0.726 | normal | 38.03 |
| Bihar | 2.44 | 0.293 | normal | 60.73 |
| Tripura | 0.448 | 0.799 | normal | 23.30 |
| Nagaland | 0.977 | 0.613 | normal | 27.27 |
| Andhra Pradesh | 1.289 | 0.521 | normal | 17.61 |
| Assam | 0.934 | 0.626 | normal | 27.80 |

Source-Computed by author

**[2]** There is positive association between the HDIs and per capita GSDP of all Indian States during study periods and the relationships are steadily improving from 1999-2000 but volatile from 1983 to 1993.

In 1983, the association between all the HDIs of all states and the GSDP of all states is significantly positive.

$\text{Log}(g_{10}) = 8.347701 + 0.338129\log(h_{10})$

(108.83)* (6.67)*

$R^2=0.64$ ,F=44.61* ,DW=1.86.,$g_{10}$=GSDP per capita of all states in 1983,$h_{10}$=HDI of all states in 1983.Low DW means autocorrelation problem.

It implies that one per cent rise in HDI led to 0.338% increase in per capita GSDP of all states in 1983.

In 1987-88, the association between the HDIs of all states and the GSDP of all states is significantly positive.

$\text{Log}(g_{11}) = 8.891646 + 0.269571\log(h_{11})$

(121.16)* (7.23)*

$R^2=0.67$ ,F=52.37* ,DW=2.08.,$g_{11}$= GSDP per capita of all states in 1987-88,$h_{11}$= HDI of all states in 1987-88.

It states that one per cent increase in HDI per year led to 0.269% increase in GSDP per capita per year in 1987-88.

In 1993, the association between all the HDIs of all states and the GSDP of all states is significantly positive.

$\text{Log}(g_{12}) = 9.590510 + 0.257492\log(h_{12})$

(91.08)* (4.17)*

$R^2=0.41$ , F=17.46* , DW=1.93,$g_{12}$= GSDP per capita of all states in 1993,$h_{12}$= HDI of all states in 1993.This estimated equation suffers from autocorrelation.

It implies that one per cent hike in HDI per year induced increase of 0.2574% of GSDP per capita in 1993.

In 1999-00, the association between all the HDIs of all states and the GSDP of all states is significantly positive.

$\text{Log}(g_{13}) = 9.900617 + 0.107377\log(h_{13})$

(156.023)* (3.74)*

$R^2=0.359$ , F=14.04* ,DW=1.57,$g_{13}$= GSDP per capita of all states in 1999-00,$h_{13}$= HDI of all states in 1999-00.Low DW signifies autocorrelation. Low $R^2$ showed very poor fit.

It means that one per cent rise in HDI led to 0.1073% rise in GSDP per capita per year in 1999-00.

In 2004-05, the association between all the HDIs of all states and the GSDP of all states is significantly positive.

$\text{Log}(g_{14}) = 10.83789 + 0.554063\log(h_{14})$

(121.65)* (8.11)*

$R^2=0.72$ , F=65.86* ,DW=2.55,$g_{14}$= GSDP per capita of all states in 2004-05,$h_{14}$= HDI of all states in 2004-05.

The equation states that one per cent increase in HDI per year led to 0.554% rise in GSDP per capita per year in 2004-05.

In 2009-10, the association between all the HDIs of all states and the GSDP of all states is significantly positive. One per cant HDI hike intends to 0.576% rise in GDSP per capita in 2009-10.

$\text{Log}(g_{15}) = 11.46503 + 0.576736\log(h_{15})$

(92.09)* (6.16)*

$R^2$=0.60 , F=38.03* ,DW=2.56,$g_{15}$= GSDP per capita of all states in 2009-10,$h_{15}$= HDI of all states in 2009-10.

In 2011-12, the association between all the HDIs of all states and the GSDP of all states is significantly positive. This estimated equation clearly states that one per cent rise in HDI affects 0.6012% hike in GSDP per capita per annum in 2011-12.

$$\text{Log}(g_{16})=11.78690+0.601287\log(h_{16})$$
$$(82.78)^*\ (5.28)^*$$

$R^2$=0.52 , F=27.95* ,DW=2.12, $g_{16}$=GSDP per capita of all states in 2011-12,$h_{16}$= HDI of all states in 2011-12.

**[3]** Also, the changes of HDI of all states of India have positive impact on the changes of per capita GSDP of all states during the survey periods. The relationship is gradually improving from 1999-00 to 2011-12 but volatile from 1983 to 1993.

In 1983, the association between the changes of gross state domestic products of all states and their changes of human development indices is positive but insignificant.

$$\text{dlog}(g_{10})=0.051251+0.857808\,\text{dlog}(h_{10})$$
$$(0.693)\quad (1.48)$$

$R^2$=0.083,F=2.194,DW=2.409

It states that one per cent rise in the change of HDI led to rise 0.857% of change in GSDP per capita per annum in 1983.

In 1987-88, the association between the changes of gross state domestic products of all states and their changes of human development indices is positive and significant. It states that one per cent rise in the change of HDI led to rise 0.326% of change in GSDP per capita per annum in 1987-88.

$$\text{dlog}(g_{11})=0.014469+0.326369\,\text{dlog}(h_{11})$$
$$(0.260)\quad (2.162)^*$$

$R^2$=0.163,F=4.675,DW=2.45

In 1993, the association between the changes of gross state domestic products of all states and their changes of human development indices is positive but insignificant. It states that one per cent rise in the change of HDI led to rise 0.394% of change in GSDP per capita in 1993.

$$\text{dlog}(g_{12})=0.00166+0.394\,\text{dlog}(h_{12})$$
$$(0.693)\ (1.85)$$

$R^2$=0.125,F=3.43,DW=2.18

In 1999-00, the association between the changes of gross state domestic products of all states and their changes of human development indices is positive but insignificant. It states that one per cent rise in the change of HDI led to rise 0.0412% of change in GSDP per capita in 1999-00.

$$\text{dlog}(g_{13})=-0.0444+0.041217\,\text{dlog}(h_{13})$$
$$(-0.65)\ (1.66)$$

$R^2$=0.103,F=2.77,DW=2.30

In 2004-05, the association between the changes of gross state domestic products of all states and their changes of human development indices is positive but insignificant. It states that one per cent rise in the change of HDI led to rise 0.262% of change in GSDP per capita in 2004-05.

$$\text{dlog}(g_{14})=0.255+0.262\,\text{dlog}(h_{14})$$
$$(1.47)\ (2.014)$$

$R^2$=0.144,F=4.059,DW=2.53

In 2009-10,the association between the changes of gross state domestic products of all states and their changes of human development indices is positive and significant but it is very poor fit because $R^2$ is very low. It states that one per cent rise in the change of HDI led to rise 0.712% of change in GSDP per capita per year in 2009-10.

$dlog(g_{15})=0.00095+0.712341dlog(h_{15})$

(0.009) (2.288)*

$R^2=0.179$, F=5.23,DW=3.01

In 2011-12, the association between the changes of gross state domestic products of all states and their changes of human development indices is positive and significant with poor fit. It states that one per cent rise in the change of HDI led to rise of 0.712% change in GSDP per capita per year in 2011-12.

$dlog(g_{16})=-0.002837+0.7123dlog(h_{16})$

(-0.029) (3.545)*

$R^2=0.343$,F=12.56,DW=2.76,*=significant at 5% level

**[4]**The impact of HDI of high plus medium human development of eight states of India on their per capita GSDP is positive and is steadily improving from 1983 to 2011-12.

**(i)** In 1983,one per cent rise in HDI of high plus medium human development states in India led to 0.4678% increase in per capita GSDP per year insignificantly.It is a very poor fit. (logHDI=x,logGSDP per capita=y). In Figure 6, the scatter diagram is fitted into the linear upward line.

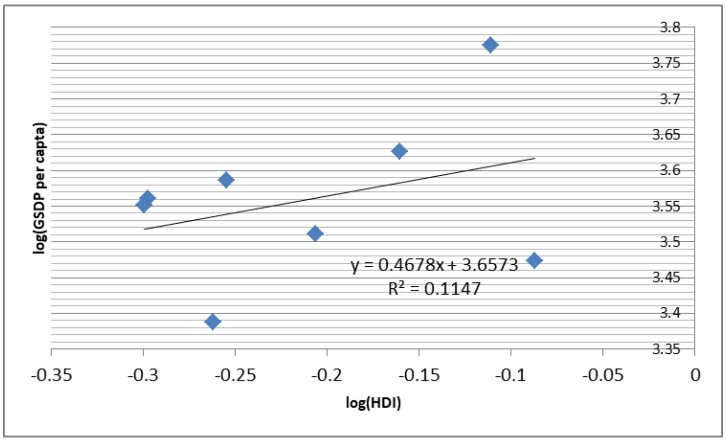


**Figure 6: Linearity between HDI of high plus medium human development states and per capita GSDP in 1983.**

Source-Plotted by author

**(ii)** In 1987-88 one per cent increment in HDI of high plus medium human development states in India led to 0.0696% increase in per capita GSDP per year insignificantly.It is not a good fit. In Figure 7, the fitted linear line shows upward sloping.

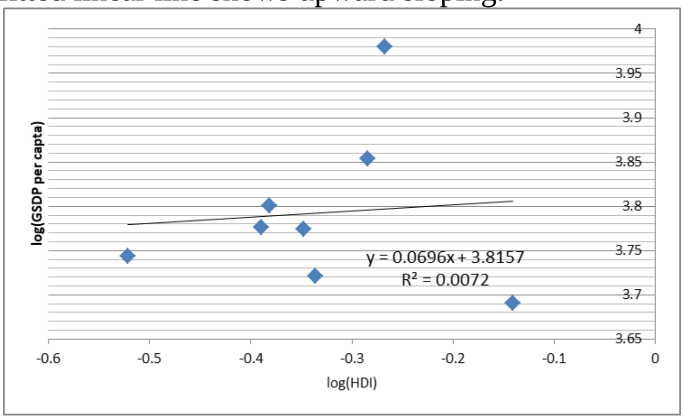


**Figure 7: Estimated line between HDI of high and medium human development states and per capita GSDP in1987-88**

Source-Plotted by author

**(iii)** One per cent rise in HDI of high plus medium human development states in India led to 0.1276% increase in per capita GSDP per year insignificantly in 1993.It is also very poor fit. The fitted linear line among the scatter points showed upward sloping.

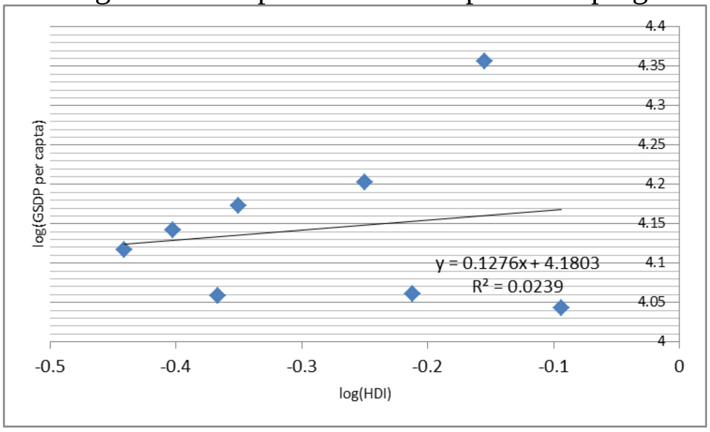


**Figure 8: Estimated line between HDI of high plus medium human development states and per capita GSDP in1993**

Source-Plotted by author

**(iv)** One per cent rise in HDI of high plus medium human development states in India led to 0.4462% increase in per capita GSDP per year insignificantly in 1999-00.It is very poor fit. The linear fitted line is upward sloping as shown in Figure 9.

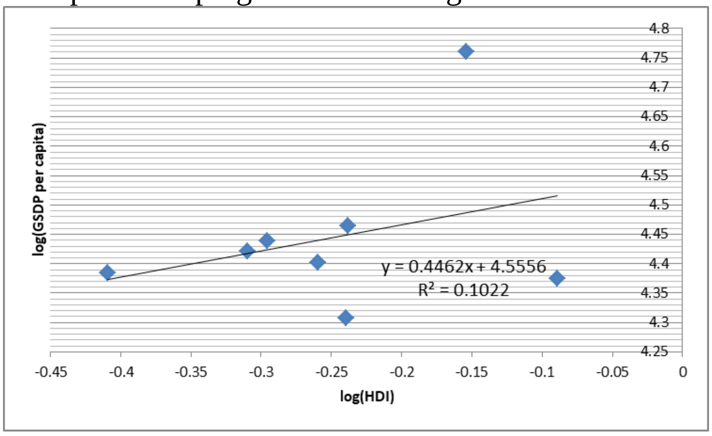


**Figure 9: Estimated line between HDI of high plus medium human development states and per capita GSDP in1999-00**

Source-Plotted by author

**(v)** In 2004-05 one per cent rise in HDI of high plus medium human development states in India led to 0.439% increase in per capita GSDP per year insignificantly. It is a poor fit. The fitted linear line is upward sloping which is plotted in Figure 10.

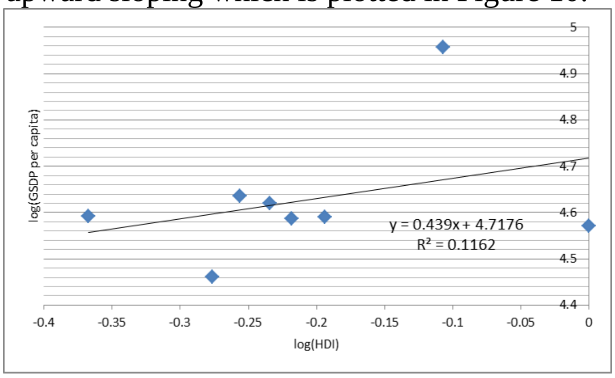


**Figure 10: Estimated line between HDI of high plus medium human development states and per capita GSDP in 2004-05.**

Source-Plotted by author

**(vi)** In 2009-10 one per cent increase in HDI of high plus medium human development states in India led to 0.6564% increase in per capita GSDP per year insignificantly. It is also a poor fit.

In Figure 11, the scatter points of the data have been fitted linearly.

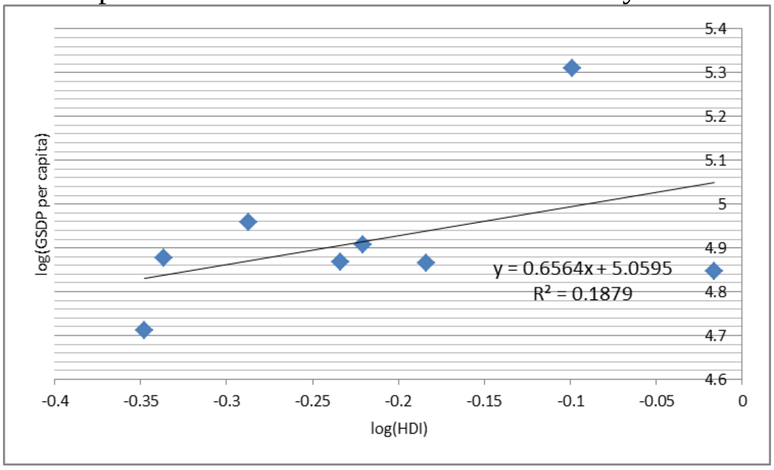


**Figure11: Estimated line between HDI of high plus medium human development states and per capita GSDP in2009-10.**

Source-Plotted by author

**(vii)** One per cent increase in HDI of high plus medium human development states in India led to 0.6975% increase in per capita GSDP per year insignificantly in 2011-12.It is a poor fit. The linearly fitted line is seen in Figure 12.

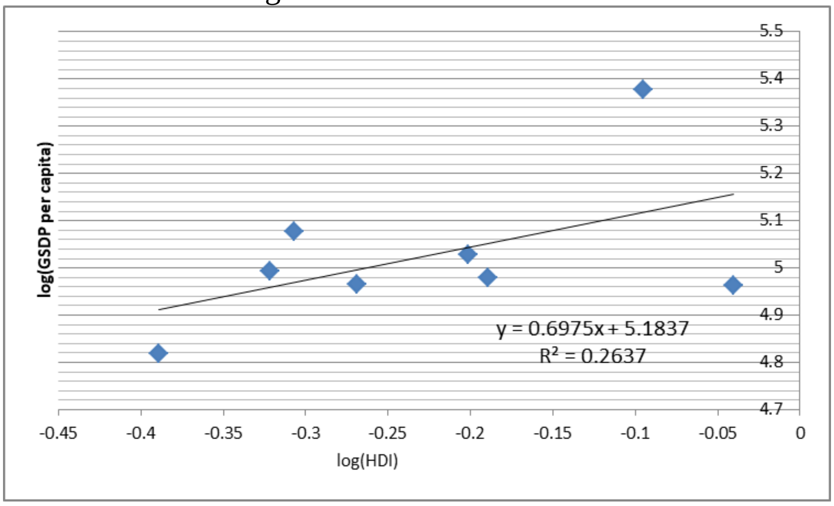


**Figure12: Estimated line between HDI of high plus medium human development states and per capita GSDP in2011-12**

Source-Plotted by author

**[5]** But the impact of HDIs of low human development of 20 states of India on their per capita GSDP during specified periods is positive but showing both increasing and decreasing patterns.

**(i)** A one per cent increase in HDI of low human development states of India leads to 0.34% increase in per capita GSDP per year significantly in 1983.(logHDI=x,logGSDP per capita=y) The linearly fitted line is upward sloping which is plotted in Figure 13.

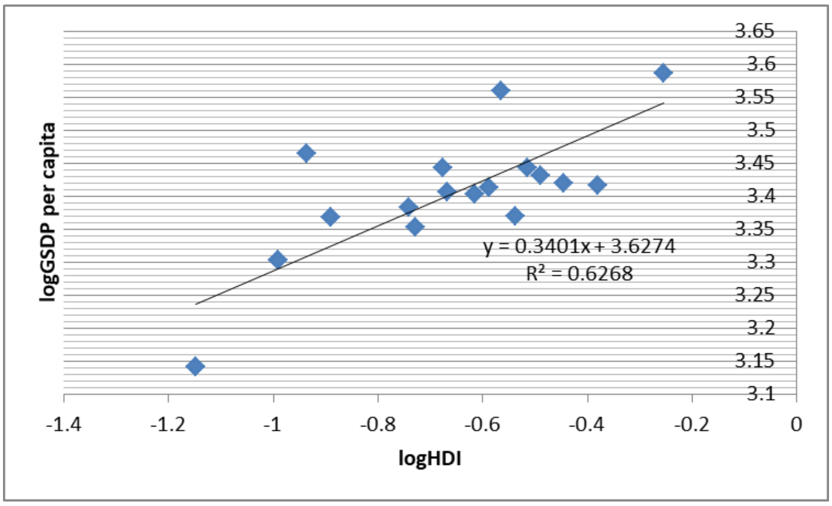


**Figure13: Linearity between HDI of low human development states and GSDP per capita in 1983**

Source-Plotted by author

**(ii)** A one per cent increase in HDI of low human development states in India leads to 0.254% increase in per capita GSDP per year significantly in 1987-88.

The upward sloping fitted linear straight line is seen in Figure 14.

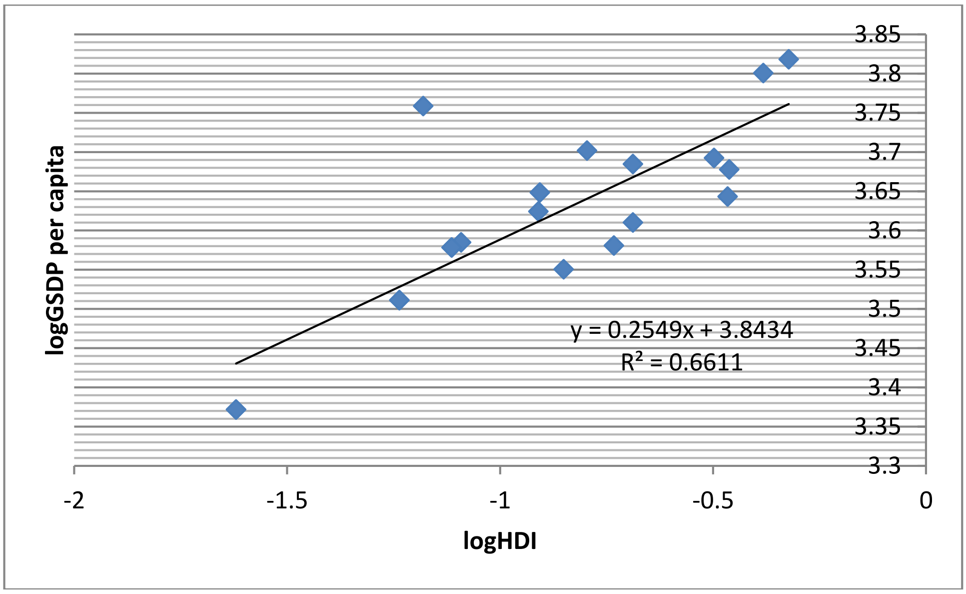


**Figure 14: Linearity between HDI of low human development states and GSDP per capita in 1987-88**

Source-Plotted by author

**(iii)** One per cent rise in HDI per year of low human development states of India leads to 0.195% increase in per capita GSDP per year insignificantly in 1993.

In Figure 15, the fitted linear line is plotted clearly.

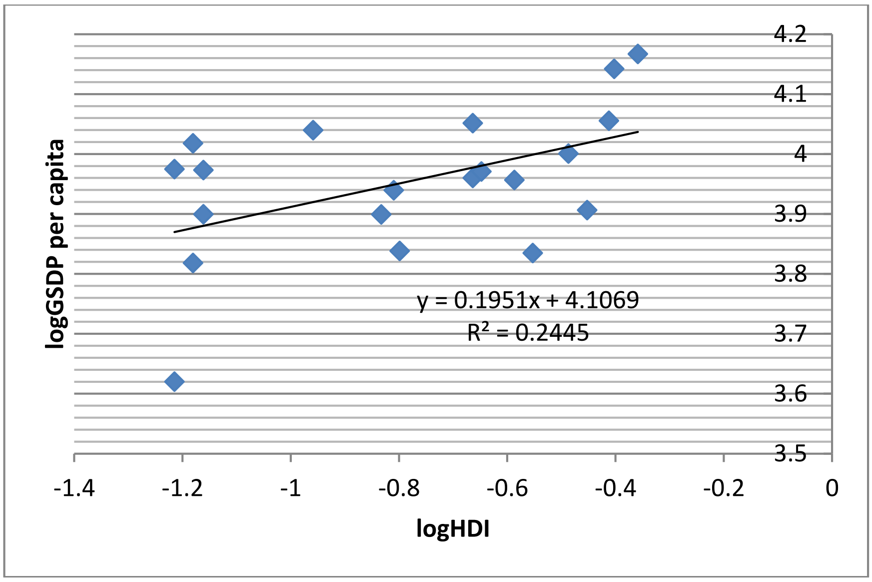


**Figure15: Linearity between HDI of low human development states and GSDP per capita in 1993**

Source-Plotted by author

**(iv)** If HDI of low human development states of India increases one per cent per year then per capita GSDP leads to 0.437% increase per year significantly in 1999-00.

In Figure 16, the linearly fitted line is shown clearly.

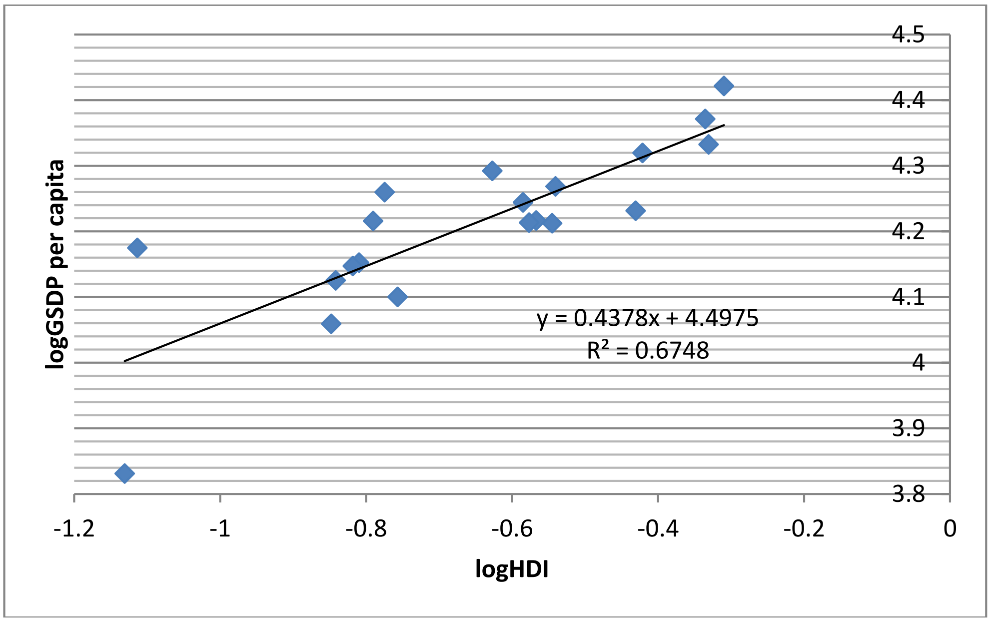


**Figure16: Linearity between HDI of low human development states and GSDP per capita in 1999-00**

Source-Plotted by author

**(v)** In 2004-05, one per cent hike in HDI of low human development states of India induced to rise 0.556% GSDP per capita per year significantly.

Linearly fitted line is plotted in Figure 17.

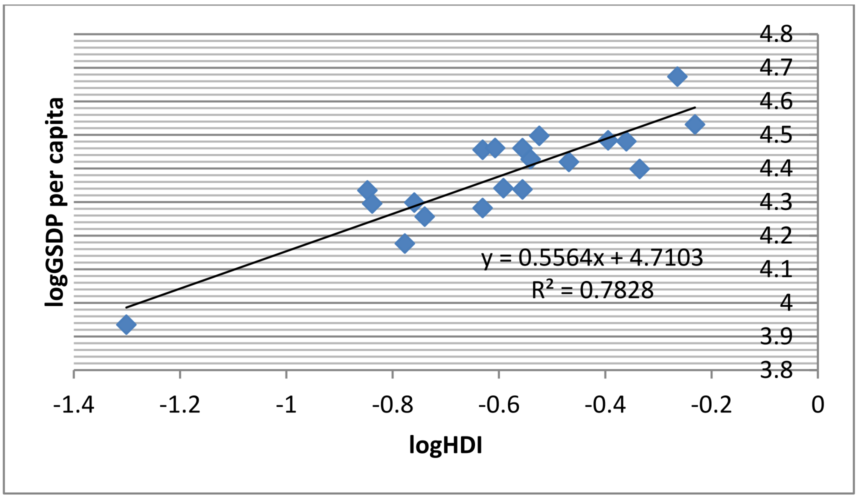


**Figure17: Linearity between HDI of low human development states and GSDP per capita in 2004-05**

Source-Plotted by author

**(vi)** One per cent increase in HDI of low human development states of India leads to 0.518% increase in per capita GSDP per year significantly in 2009-10.

The scatter diagram is fitted as upward linear line which is shown in Figure 18.

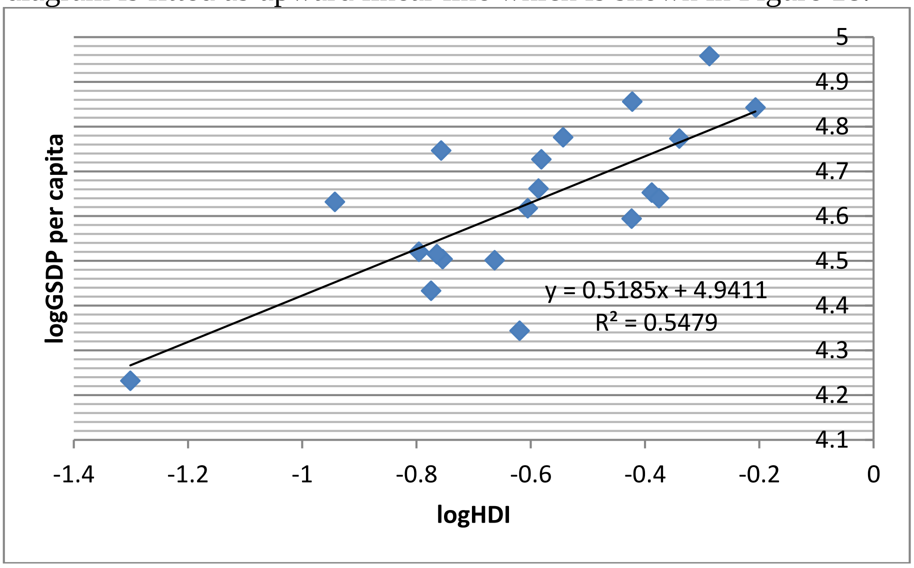


**Figure 18: Linearity between HDI of low human development states and GSDP per capita in 2009-10**

Source-Plotted by author

**(vii)**In 2011-12, one per cent rise of HDI of low human development states of India leads to 0.6009% rise of per capita GSDP per year significantly.

In Figure 19, the linear line is shown upward sloping.

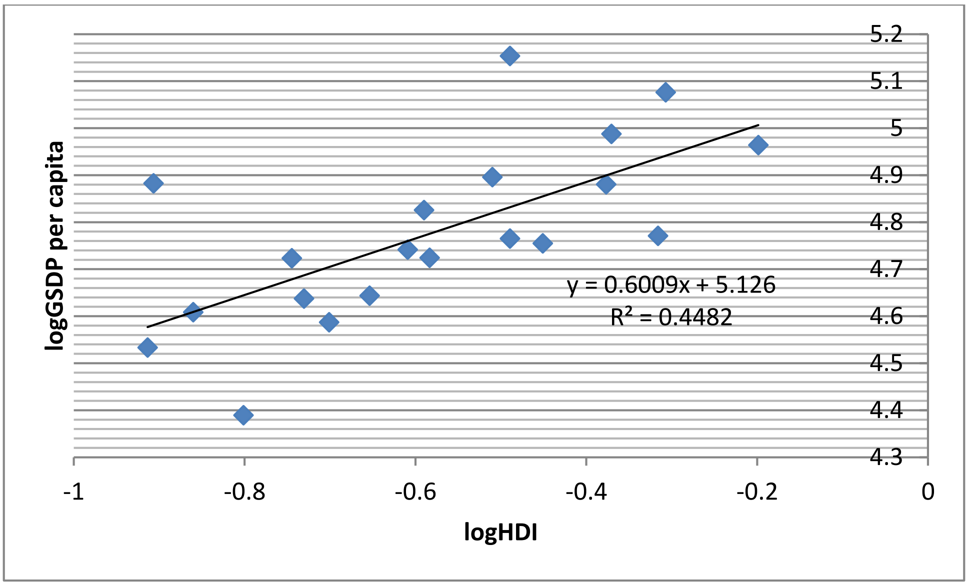


**Figure 19: Linearity between HDI of low human development states and GSDP per capita in 2011-12**

Source-Plotted by author

**[viii]** Lastly, taking India's 28 states' HDI and per capita GSDP during 1983,1987-88,1993,1999-00,2004-05,2009-10,2011-12 , Mukherjee, Chakraborty and Sikdar (2014) estimated the following fixed effect panel data regression equation.

Log (HDI) =-2.658+0.14log (GSDP per capita)

(0.181)* (0.019)*

$R^2$=0.25, F=56.53*, N=196, *=significant at 1% level.

It states that one per cent increase in GSDP per capita in all states led to 0.14 per cent increase in HDI of all 28 states in India during the said period. This estimate of the fixed effect model is significant at 1 % level.

**(ix). Convergence of States' HDI**

Following Sala-i-Martin (1996), the convergence criteria of Sigma convergence hypothesis assumed that the linearity of coefficient of variation of a variable would be downward sloping significantly. The calculated coefficients of variations of all states in India during the specified periods are tabulated below.

**Table 10: Coefficient of variations**

| year | Coefficient of variation of HDI of all states |
|---|---|
| 1983 | 0.655731 |
| 1987-88 | 0.750361 |
| 1993 | 0.704647 |
| 1999-00 | 0.564525 |
| 2004-05 | 0.578316 |
| 2009-10 | 0.58639 |
| 2011-12 | 0.554042 |

Source-Calculated by author

The trend line of coefficient of variation through semi-log regression model is estimated as

Log(y) =-0.300673-0.041556t

(-4.39)* (-2.715)*

$R^2$=0.59, F=7.37*, DW=2.29,*=significant, y=coefficient of variation of HDI of all states=year

The coefficient of variations of HDI of all states have been declining at the rate of 4.15% per year which is significant at 5% level which proves the validity of sigma convergence of

HDI of all states in India. These findings imply that unequal development exists in Indian states which mean that there are wide variations of poverty and inequality, health and education facilities and unemployment rates in all the states in India but these are dwindling gradually. In Figure 20, the fitted line is plotted below.

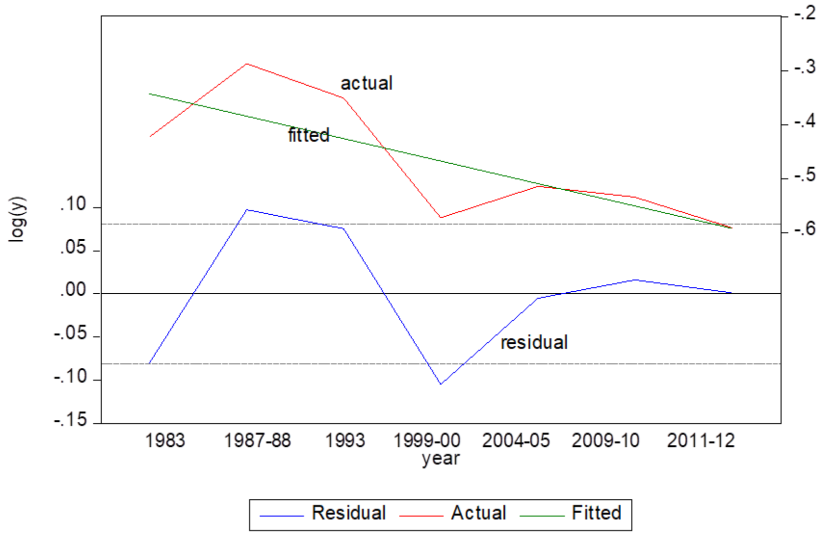


**Figure 20: Sigma convergence**

Source-Plotted by author

The Sigma convergence of HDI of Indian states became significant because the growth rates of social sector expenditure of all states have been increasing significantly more than 10.0% per year from 1990-91 to 2016-17 which means expenditure on education and health have been catapulted by larger scale for which HDI have improved. On the contrary, growth rates of HDI of all states had not been raised equally with the social sector expenditure. Only, Maharashtra, Tamil Nadu, West Bengal, Sikkim, Odisha, and Tripura showed significant growth rate of HDI during 1983-2011-12.The HDIs of other states have been increasing insignificantly. Even, Punjab, Mizoram, Manipur and Assam have achieved negative growth rates of HDI which are exception to the general theory that a hike in education and health expenditure might hike HDI but these rates were insignificant. In the Table 11, the values have been arranged clearly.

**Table 11: Growth of HDI and Social sector expenditure of all states**

| Indian States | Growth rate of social sector expenditure | Significant/insignificant | Growth rate of HDI | Significant/insignificant |
|---|---|---|---|---|
| Kerala | 11.85 | Significant | 3.98 | Insignificant |
| Goa | 13.20 | Significant | 3.55 | Insignificant |
| Punjab | 11.39 | Significant | -1.37 | Insignificant |
| Himachal Pradesh | 12.56 | significant | 4.15 | Insignificant |
| Mizoram | 11.65 | Significant | -3.66 | Insignificant |
| Maharashtra | 12.77 | Significant | 6.10 | Significant |
| Gujarat | 13.04 | Significant | 3.10 | Insignificant |
| Haryana | 14.52 | Significant | 1.40 | Insignificant |
| J&K | 12.57 | Significant | 5.47 | Insignificant |
| Karnataka | 13.36 | Significant | 3.21 | Insignificant |
| Tamil Nadu | 12.71 | Significant | 11.76 | Significant |

| | | | | |
|---|---|---|---|---|
| West Bengal | 13.02 | Significant | 7.03 | Significant |
| Manipur | 11.99 | Significant | -4.21 | Insignificant |
| Meghalaya | 12.38 | Significant | 8.17 | Insignificant |
| Sikkim | 13.94 | Significant | 11.86 | Significant |
| Odisha | 13.27 | Significant | 7.92 | Significant |
| Rajasthan | 13.42 | Significant | 16.08 | Insignificant |
| Madhya Pradesh | 11.83 | Significant | 13.12 | Insignificant |
| Arunachal | 13.30 | Significant | 10.37 | insignificant |
| Uttar Pradesh | 13.27 | Significant | 13.32 | Insignificant |
| Bihar | 11.92 | Significant | 13.10 | Insignificant |
| Tripura | 12.01 | Significant | 8.63 | Significant |
| Nagaland | 11.06 | Significant | 5.17 | Insignificant |
| Andhra Pradesh | 12.51 | Significant | 4.92 | insignificant |
| Assam | 12.88 | Significant | -1.79 | insignificant |

Source-Calculated by author

## 5. Limitations and further scope of research

All the states have been classified as high, medium and low human development following Human Development Report where only Kerala was the high human development state, therefore author assumed two categories such as [i]high plus medium and [ii] low, but some economists studied high, medium and low human development states through indicator of GDP at ppp. Secondly, panel data analysis through Strata package is absent here. Thirdly, the explanation of convergence of HDI of Indian states through Sigma convergence hypothesis is included in this paper. Beta convergence test is left for future research. Relation between states' health and education expenditure with HDI in panel data is to be verified in due course.

## 6. Policy suggestions

India's expenditure on education and health is very low compared to other developed nations. Therefore, the indicators of education and health had not been improved during last 70 years of planning. India lacks needs of basic education and health facilities. India's Gender Development Index and Gender Empowerment Measure index are very low due to inequalities of gender education and health. India's gender budgeting policy is not encouraging. India should give more priorities on those areas in terms of investment for betterment of human capital. FDI inflows may be encouraged in health and education sectors in India.

## 7. Conclusions

The paper concludes that HDI of India has been increasing at the rate of 1.55% per year from 1990 to 2016.HDI has three upward structural breaks in 1996, 2004 and 2011 respectively. One per cent increase in HDI of India led to 1.41% increase in growth rate during 1990-2016.This relationship between HDI and growth is co-integrated and they have no causality. Their VECM is stable but nonstationary and error correction is significant and fast for equation$\Delta \log x_{3t}$.Moreover, one per cent rise in HDI per year led to 5.86% rise in GDP, 4.828 % increase in GDP per capita and 0.5028% decrease in unemployment rate per year respectively during 1990-2016 in India. Even, HDI has unidirectional causality with GDP and GDP per capita .There is positive association among GSDP and GSDP per capita with high plus medium human development and low human development states of India for those years. In Fixed effect model of panel data, the regression between of all states' HDI and GSDP per capita is positive .This paper finds sigma convergence of HDI of all states. Only four states showed negative growth of HDI in spite of their rising trends of social sector expenditure. The paper recommended to enhance government expenditure on education and health including gender budgeting and FDI inflows.

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**ANNEXURE**

Group 1: High plus Medium Human Development States of India in 1983(HDI above 0.500

-Kerala, Goa, Punjab, Himachal Pradesh, Mizoram, Maharashtra, Gujarat, Haryana

Group 2: Low Human Development States in India in 1983(HDI below 0.500)

-Jammu & Kashmir, Karnataka, Tamil Nadu, West Bengal, Manipur, Andhra Pradesh, Nagaland, Tripura, Assam,Meghalaya,Sikkim,Odisha,Rajasthan,Chhatrisgarh,MadhyaPradesh,Arunachal Pradesh, Uttar Pradesh, Uttarakhand, Jharkhand, Bihar.