HUMAN CAPITAL FORMATION AND ECONOMIC GROWTH RELATIONSHIPS: PANEL DATA INSIGHTS FOR THE INDIAN STATES

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Abstract

The various endogenous growth theories as well as empirical studies have proved that human capital works as an important factor for economy's growth. The role of income on human capital formation cannot be overlooked so far as the essences of the endogenous growth theories are concerned. Considering this interconnection among the human capital and income of the economy, the present study provides quantitative evidence to show the associations amongst human capital formation as quantified by the governments' health and education expenditures and income of the economy measured by states' gross domestic products for the panel of states and union territories of India during the period from 1998-99 to 2018-19. The technique of panel cointegration is used to show the long run relationships among human capital investment and income of the economy, and then the Wald test is used to examine the direction of short-run causality. The empirical results demonstrate that human capital and state incomes have a long-term relationship. The Wald test reveals a short-run linkage between human capital and income of the state economies, with the causality running from human capital investment to output of the economy. i.e., human capital has an immediate influence on the progress of the economy. It is consequently suggested that the governments of the states and union territories make additional investments in sectors such as education and health in order to secure long-term economic prosperity.

Keywords: Human capital, education, health, growth, panel cointegration, Indian states
JEL classification: I1, I2, O3, C32, C33

1. Introduction

Human capital, together with physical capital and labour force, is recognized as one of the most essential components of production in the modern world. It is generally related with economic growth since investments in human capital tend to raise the efficiency and throughput of an economy's present force of labour. It is said that increased human capital leads to increased progress of the economy. Smith (1776) contends that progress of the economy is determined by the skill, deftness, and decision through which labour is employed in general, emphasizing on the components that determine labour productivity increase. To Lucas (1988), the gathering of human capital is vital for long term progress of the economy, and education is the main resources of gathering human capital. As per Romer (1986, 1990), human capital generates innovations and ultimately rouses economic growth. Contrary to these results, Barro and Sala-i-Martin (1995) discovered that education is directly connected with growth rates of per capita GDP across countries. Various empirical evidences indicate the significance of health as the component human capital with regard to growth of an economy. Economic growth, it is often assumed, leads to better living standard, longer life expectancy, and improved health conditions. To start with, expansion of an economy involves increasing per capita wealth, and a portion of this increased wealth is converted to rising intake of nutrients in both the quantitative and qualitative aspects. Economic growth contributes to the human capital accumulation (Mincer, 1995). The existing theories on endogenous growth incorporating human capital factor established favorable growth effects in some countries and not so relevant in other countries. As a result, the prevailing macroeconomic theories inferred causal chain between human capital accumulation and

growth of the economy and appears to be somewhat vague; it differs across countries or across groups of countries. Thus, the present study aims to show the interconnections of human capital formation with growth of income at the micro level by taking the panel of 29 Indian states and UTs (union territories) for the period of 1998-99 to 2018-19.

2. Review of Extant Works

First the study covers up the review of works on the relationships between human capital (in different forms) and economic growth and development in countries and groups other than India. Then it goes for capturing the studies on the same field for India only.

Becker (1964) created an economic approach to human capital by focusing on the assumptions about general-purpose and firm-specific human capital. Mankiw, Romer and Weil (1992) suggested that the outcomes of the Solow's model were consistent with international evidence if the amounts of human capital and physical capital were valued equally. Benhabib and Spiegel (1994) highlighted the finding that human capital had a negligible influence on per capita income growth rates, and then employed an alternative model in which human capital had a direct effect on the total factor productivity growth. Brempong and Wilson (2004) looked into the effects of health capital on the growth of per capita income in the Sub-Saharan African and OECD group and revealed a quadratic relationship of health as human capital had with the growth of per capita income. According to the estimations, health capital books for 22% and 30% of the changeover growth rates in the respective groups. Using panel data including 93 countries, the study of Agiomirgianakis (2002) showed that education as factor of the economic output had a substantial and direct long run effects. In addition, as the level of education increased the size of this effect also get stronger. Wolff (2000) inspects the upshot of education in growth of the economies in the 24 OECD group from 1950 to 1990. The rise in educational attainment appears to be in lockstep with the rise in labour productivity. However, across a wide variety of specifications, a variable quantifying the figure of engineers and scientists employed per head is found to be important. From 1980 to 2008, Yardimciolu and Gürdal (2014) explored the long run link among growth of the economy and education levels in the group of 25 OECD nations and found a long run one-way causal influence from growth of the economy to the level of education.

Hanushek (2013) mainly focused on developing countries in terms of school attainment, school quality. He argued and found that without improvement of school quality, developing countries doesn't achieve of improve their long run economic performance. Bas van Leeuwen (2008) observes, during 20th century, that human capital base is cointegrated with the total income base in Indonesia and India which supports the outcomes of the Lucas model. Edrees (2016) studied Arab World countries from 1974 to 2013, and found non-uniform causal relationships at diverse heights of affluence. According to Permani (2009), education is important for economic growth, but it is not adequate in East Asia. Regardless of whether education may boost productivity, it continuously appears as a substantial income determinant and, as a result, a growth component. McMahon (1998) started a production function with the externality effects of education to the East Asian countries. It is discovered that, because most nations had universal primary education early on, the rate at which secondary education grew (which is required for successful exports) was critical in obtaining sizable rates of asset creation in the education sector and per capita income growth. After primary enrolment is universal, secondary and higher education costs become more significant. Oketch (2006) establishes a link between the development of human resources as a result of formal education and per capita economic growth. The study's conclusion is that the per capita income growth is a determining factor of investment in education which is statistically consistent. Kouton (2018) investigated the association for Côte d'Ivoire during 1970-2015 and shows a unidirectional causality relationship runs from education spending to income growth. The study of Qadri and Waheed (2011) for Pakistan using time series data during 1978 to 2007 shows that both education and health spending leading to the generation of human capital are cointegrated with the growth of the country. Islam, Wadud, and Islam (2007) used data of 1976-2003 for Bangladesh and the evidence of a two-way causal interplay between education level and income growth is seen in the empirical findings. On the other hand, Rahman (2011) explored the causal relationship between health expenditure, education expenditure, and GDP

in Bangladesh for the period 1990-2009 and discovered feedback causal relation between GDP and education spending as well as one-way causal influence as of health spending to the GDP of the country. Korres and Tsamadias (2009) investigated the relationship between productivity and technological change and its consequences upon regional economic growth in Europe and found a close relationship between innovation and productivity levels. However, there were large technological disparities between the member states, which affected productivity performance, increased economic disparities and hinders economic integration. In another study, Korres and Kokkinou (2011) elucidated the consequences of innovative activities on the process of regional convergence in Europe and found divergence. Mehrara and Musai (2013) found a causal association of education level with the levels of GDP in the developing nations. They discovered a substantial link between the two in developing countries for 1970-2010. Avdi (2013) focused on the structure of health insurance system's contribution in Albania. According to the study, one of Albanian politics' biggest issues had been and will continue to be the need for healthcare reform which might enhance the quality of human capital in the country. According to Purnastuti (2016), education had a large positive impact on labour productivity, which was a key factor in both economic growth and overall human development. Malesevic et al (2019) obtained the results for EU15 countries during 1995-2014, where the single most important government expenditure item was education among aggregate expenditure for economic growth. In the Troso traditional waving business, where human capital had a substantial impact on competitive advantages and company success, Ngatindriatun et al. (2020) examined the relationship between intellectual capital and competitive advantage and company performance. Vasyltsiv et al (2021) looked at how the national economy's technical competitiveness impacted fundamental measures of social and economic growth such GDP per capita, the proportion of high-tech exports, capital investment, and quality of life for fostering technological advancement. Osiobe (2020) examined the connection among education and economic progress and concluded that government education investment had a favourable impact on the countries of Latin America. Bajrami and Leka (2020) paid attention to the effects of higher education upon income of the countries. The model revealed substantial relationships and a positive correlation between the variables mean years of education and enrolment in higher education and GDP per capita. Myzrova et al (2020) aimed to estimate the innovative potential of the mesoeconomic system as a criterion which ensures development in a given direction and the results proved that the ability and determination to develop innovative activity was determined by the accumulated aggregate potential of the mesoeconomic system as a whole. In a recent study, Hussain et al (2022) examines the long-term relationship between intellectual capital and human capital formation in different income groups and show that long-term association exists between these two forms of capital for both the panels of high and low and middle-income nations. But the short-run causal interplay works in high-income group only where human capital formation is making a cause to the intellectual capital formation. Recently, Hussain et al (2022) examine the long-term relationship between intellectual capital and human capital in case of some countries from the high-income group (HIG) and low and middle-income group (LMIG) during the period of 1998 to 2018. The findings show that long-term association exists between these two forms of capital for both the panels of high and low and middle-income nations, but in the short-run, causal interplay from human capital formation to the intellectual capital formation works in high-income group only. There are a list of research works on the interrelationships between R&D activity, a source of knowledge capital, economic growth and trade liberalizations in world's leading countries that demonstrate no linkage from R&D to income, etc. (Das and Mukherjee, 2019; Das, 2020; Rahmi & Alliasuddin, 2020; Das and Chatterjee, 2020).

Let us come to the review of the studies for India. Haldar (2009) attempts to examine Lucas model in the context of income growth in India from 1950–51 to 2003–04. Applying cointegration tool he finds that investment on human capital has important contribution to income growth of the country in both the long run and short run. The theoretic and experiential rationale for government's educational investment in India is reviewed by Dastidar, Mohan and Chatterji (2013). Education spending is essential but not enough for economic growth. However, the efficacy of spending on education appears to be influenced by the economy's institutional and labour market features. Sharma and Sahni (2015) affirmed

the long run associations between human capital investment and economic growth in India through co-integration test during 1991 to 2012. Further, there is the occurrence of bidirectional causal interplays between human capital and economic growth. Self and Grabowski (2003) investigate if the causal outcomes differ depending on gender in India. The findings display that basic education is having large causal influence on income growth, whereas secondary education offers less evidence of such an impact. Finally, there is overwhelming evidence that education to the female, at all stages, is also having the ability to spur growth of Indian economy. According to Pradhan (2009), India should focus on the development of human capital too with the physical capital in order to get sustained growth of the country. On the other hand, education is important in Pakistan as it has positive effects on economic growth both in the long run and short run (Afzal et al, 2010). Chandra (2010) examines the causative associations of educational expenses with growth of the Indian economy from 1951 to 2009 and results show that, regardless of any lag effects, income growth impacts the level of public spending on the education head, and also the reverse causality is observed after a time lag. Chakraborty and Krishnankutty (2012) look at education spending as one of the crucial factors of India's growth. However, education spending as a percentage of total spending is not significant in the North Eastern States. On the other study, the effect of educational expenses on India's growth was investigated by Abubakar and Abdulkadir (2015) and it did not find any such cointegrating relations between the two variables. Shukla (2017) investigated the role of expenditure on health care in India's economic growth from 1995 to 2014, and observes a strong and direct associations among them. Not only health, but the secondary School enrollment also affects the Indian economy positively. Parika and Singh (2020) examine the function of human capital in determining output in the Indian market from 1980 to 2017 and the study finds long term impact of human resource upon the economy.

3. Research Gaps and Research Questions

Although there are some studies on the interrelationships between human capital formation and income of India in particular and other economies in general the extant literature does not have any studies on the same theme at the state levels of India. Keeping in mind the fact that human capital is much more affected by the state governments' policies; the present study aims to visualize the interconnections of investment upon human capital formation (which is the sum of education expenditure and health and healthcare expenditure) with income by taking a panel of 29 states/UTs of India from 1998-99 to 2018-19.

The research questions under the study are two folds which are as follows:

1. Are there long run relationships and short run dynamics between human capital investment and income in the panels of Indian states and union territories?
2. Do there exist causal interplays between human capital investment and income in the panels of Indian states and union territories?

3.1. Major Hypotheses of the Study

1. There are no long run relationships and short run dynamics among the panels of human capital investment and output in Indian states and union territories during 1998-99 to 2018-19.
2. No causality exists between the panels of human capital investment and income in Indian states and union territories during 1998-99 to 2018-19.

3.2. Contributions of the Study

The study has contributed to the field of research in the following ways-

1. It addresses how the public expenditure on education and health help in generating human capital and as a result, how human capital influences economic growth.
2. Though there has been a list of works in the related areas in aggregate economy levels, no studies so far have gone through to investigate the same relations in a further micro levels like state/county levels. The present study has focused upon the states and union territory of India to examine whether human capital patronized by education and health expenditures by the state governments have any long run and short run relationships.

4. Theoretical Model

The neoclassical growth theory assumes the exogenous technological progress and diminishing marginal productivity to capital which allows the countries to make convergence to a unique steady state income and per capita capital. Nonetheless the empirical evidence of the performance of the so called developed nations in the eighties showed that the countries, having far greater amount of the stock of physical capital, outperformed the less developed economies having very low levels of physical capital, thereby negated the validity of the predictions of the neoclassical growth theory. A new group of economists emerged who opined that the growth difference in the eighties was due to the working of some factors other than the savings rate, population growth rate etc. as supposed by the neoclassical theory, which broke the assumption of exogenous technological progress, in place they postulated the endogenous technological progress in terms of human capital generation, knowledge capital formation, institutional supports, etc. which are evidenced from the studies such as Romer (1986 &1990); Lucas (1988); Barro and Sala-i-Martin (1995).

There have been lots of empirical verifications of the endogenous growth postulations; the present study is based upon the impact of human capital formation in the states' and union territories' economic growths as well as in whole India. For that purpose, the study is based upon the theoretical structure of Lucas (1988).

It is assumed that labour force, proxied by the stock of population, is capable of producing both the physical as well as human capital. Introduction of the effects of human capital is capable of breaking the diminishing marginal productivity property of capital, and allowing the aggregate production function to follow increasing returns in the system.

Suppose, the neoclassical production function looks like –

1. $Y = AK^{\alpha}L^{\beta}$

where $0< \alpha, \beta<1$ and $\alpha + \beta \leq 1$. 'α' and 'β' respectively indicate output elasticity of capital and labour, and A stands for the factor of exogenous technological progress that makes changes in the factor productivity. Here marginal productivity of capital (MPK) is diminishing.

The rent on capital 'r' is the difference between MPK and rate of depreciation (d), i.e.

2. $r = MPK - d = A\alpha\, K^{\alpha-1}L^{\beta} - d$

Rate of growth of r is-

3. $dr/dt = A\alpha\,(\alpha-1)K^{\alpha-2}L^{\beta}.(dK/dt) + A\alpha\,\beta K^{\alpha-1}L^{\beta-1}.(dL/dt)$

At the steady state, $dr/dt = 0$

Hence,

4. $A\alpha\,(\alpha-1)k^{\alpha-2}L^{\beta}.(dK/dt) = -A\alpha\,\beta K^{\alpha-1}L^{\beta-1}.(dL/dt)$

5. Or, $(\alpha-1)(dK/dt)/dt = -\beta.\,(dL/dt)/L$

6. Or, $(dK/dt)/K = -[\beta/(1-\alpha)].(dL/dt)/L)$

Taking the growth of labour force at the rate n (i.e.$(dL/dt)/L = n$), the above relation is reduced to-

7. $(dK/dt)/K = -\beta n/(1-\alpha)$

This means, the rate of growth of physical capital is directly related to the growth rate of labour force.

In endogenous growth models, labour force is assumed to generate human capital besides physical capital. Following Lucas (1988) structure, the revised production function can be written as-

8. $Y = AK^{\alpha}H^{\theta}L^{\beta}$

Here $0<\alpha, \beta, \theta<1$ and $\alpha + \beta + \theta > 1$ which ensures the break or non-working of the diminishing marginal productivity channel and generating the scope of positive growth rates of income even with high values of capital/income in the initial time point. The rate of growth of K and H are now related to the rate of growth of labour force in the following way-

9. $(dK/dt)/K + (dH/dt)/H = (dL/dt)/L$

The marginal productivity of capital is now-

10. $dY/dK = A\alpha K^{\alpha-1}L^{\beta}H^{\theta}$

or, $New\ dY/dK = Old\ dY/dK.H^{\theta}$

This means,

11. $New\ dY/dK > Old\ dY/dK$

Hence, the growth rate of per capita consumption expenditure and per capita income remain positive in the longer runs. As the physical capital becomes more productive now with the inclusion of human capital than that under the neoclassical model it can now be considered that growth of income will now be greater if human capital is considered as another source of capital in the production system. Lucas model of endogenous growth is thus having the explanatory power to why the so called developed economies in the world grew more than the less developed economies in the 1980's.

The present study follows this theoretical concept in examining the interrelationships between human capital and income of the panel of states and union territories in India during 1998-99 to 2018-19. Here in the study, the level of human capital is substituted by the state governments' expenditures on the education and health sectors.

5. Data Source

Government expenditure on health (GEH) and government expenditure on education (GEE), and economic output as proxied by the Net State Value Added (NSVA) are the three major variables in this study. All of them are measured in INR lakh at the base period 2004-05. Education spending, as well as sports, art, and cultural spending, are all included in GEE. Medical, public health, and family welfare spending are all included in GEH Both GEE and GEH are based on revised budget estimates, with expenditures computed as the ratio of the total government expenditure. The secondary data is gathered from annual publications of the Reserve Bank of India (visit www.rbi.org.in) for the period 1998-99 to 2018-19. Total human capital investment (HCI) is the sum of GEH and GEE. There are 28 states and one union territory, Delhi, which are considered for the study. The new state Uttarakhand is sometimes called Uttaranchal.

6. Empirical Methodology

To carry out the study, the panel unit root tests in lines of Levin, Lin, and Chu (LLC) (2002), Breitung and Das (2005), and Im, Pesaran and Shin (2003), Fisher (1932) and Hadri (200) are implemented. For testing the panel cointegration, the present study uses the Engle-Granger (1987) two-step-residual-based-cointegration tests such as of Pedroni and Kao. Also it uses the Fisher test which is a combined Johansen test. After that, the Vector Error Correction Model (VECM) and Wald test are exercised for examining short run dynamics and causal interplays between the variables.

6.1. Panel unit root test

6.1.1. Common unit root process

The ADF equation for the LLC technique is-

$$Q\Delta Y_i = \mu_i Q + \rho Q Y_{i,t-1} + \sum_{j=1}^{p_i} \beta_{ij} Q \Delta Y_{i,t-j} + Q\varepsilon_i \quad (12)$$

Where, Q is idempotent transformation matrix. In LLC, the testing hypotheses are H_0: $\rho = 0$ and H_1: $\rho < 0$.

The t-ratio is-

$$t_\rho = \frac{\sum_{i=1}^{N} \hat{\sigma}_i^{-2} \Delta Y_i' Q Y_{i,-1}}{\sqrt{\sum_{i=1}^{N} \hat{\sigma}_i^{-2} \Delta Y_i' Q Y_{i,-1}}} \text{ where} \hat{\sigma}_i^2 = \frac{\Delta Y_i' Q Y_i}{T-2}$$

Breitung (2005) method differs from LLC. The perseverance factor ρ is estimated by the help of the following pooled equation-

13. $\Delta Y_{it}^{*} = \rho\, Y_{it-1}^{*} + v_{it}$

Where $Y_{it}^{*} = \tilde{Y}_{it} - \tilde{Y}_{i1} - \frac{t-1}{T-1}(\tilde{Y}_{iT} - \tilde{Y}_{i1})$

Breitung confirms that the resulting estimator ρ^{*} is asymptotically distributed as a standard normal under the null hypothesis.

6.1.2. Individual unit root process

In a relatively more flexible and simple method, Im, Pesaran and Shin (2003) (*IPS*) established the panel unit root test using the likelihood method. It is basically a set of ADF tests where the hypotheses are- $H_0 : \rho_1 = \rho_2 = \ldots = \rho_N = \rho = 0$ and $H_1 : \rho_1 < 0, \rho_2 < 0, \ldots, \rho_{N1} < 0$, $N_1 < N$.

The test statistic is $\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i$ where t_i is the DF t-statistic of ith cross section and is presumed to be i.i.d. with finite values of the mean and variance. The expression for t_i is $t_i = \frac{\Delta Y_i' Q Y_{i,-1}}{\hat{\sigma}_i^2 \sqrt{\Delta Y_i' Q Y_{i,-1}}}$.

Fisher (1932)-type test uses the level of significance (p_i) of the ADF statistics for the ith (i= 1, …, N) cross section unit. The hypotheses under this test are- H_0: $\rho_i = 0$ and H_1: $\rho_i < 0$, and $\rho_i = 0$ for $i = N_1 + 1, \ldots, N$, with $0 < N_1 \leq N$. The test statistic is $P = -2 \sum_{i=1}^{N} \log(P_i)$ which is used in Choi (2001) model.

The test technique of Hadri (2000) (common unit root process) is based on residual and is done by the Lagrange multiplier test. The test is on the ratio of variances. The hypotheses under the test are- H_0: $\lambda = \frac{\sigma_u^2}{\sigma_e^2} = 0$ and H_1: $\lambda > 0$ where the LM statistic is, $LM = \frac{1}{\hat{\sigma}_e^2}\frac{1}{NT^2}(\sum_{i=1}^{N}\sum_{t=1}^{T} S_{it}^2)$.

6.2. Panel cointegration test

The Engle-Granger paradigm is extended to panel data testing by Pedroni (1999, 2004) and Kao (1999). Pedroni presents a number of cointegration tests that take into account non-homogeneous intercepts and trends in different identities. The regression form of the test is as follows-

14. $Y_{it} = \alpha_i + \delta_i t + \beta_{1i} X_{1i,t} + \beta_{2i} X_{2i,t} + \ldots + \beta_{mi} X_{mi,t} + e_{it}$

Where all the Xs are taken to be I (1). Individual and trend effects are controlled via the parameters α_i and δ_i which, if desired, can be fixed to zero. The residuals e_{it} will be I(1) for no cointegration null hypothesis. The residuals are generated by the following equation-

15. $e_{it} = \rho_i e_{it-1} + \sum_{j=1}^{\rho_i} \phi_{ij} \Delta e_{it-j} + v_{it}$

Pedroni test has again many dimensions depending upon within or between estimates incorporating trends, intercepts and both.

The Kao test goes in line with the residual test where the test statistics is-

16. $\text{ADF} = \frac{t_{\bar{\rho}} + \sqrt{6N}\hat{\sigma}_v / (2\hat{\sigma}_{0v}}{\sqrt{\hat{\sigma}_{0v}^2 / 2\,\hat{\sigma}_v^2 + 3\hat{\sigma}_v^2 / (10\hat{\sigma}_{0v}^2)}}$

Fisher (1932) develops a combined test for cointegration. If Ω_i is the probability value (*p*-value) after a cross sectional cointegration test, then the following will hold when the null hypothesis will work-

17. $-2 \sum_{i=1}^{N} \log(\Omega_i) \rightarrow \chi^2 2N$

EViews reports the χ^2 value for the test based on MacKinnon-Haug-Michelis (1999) p-values.

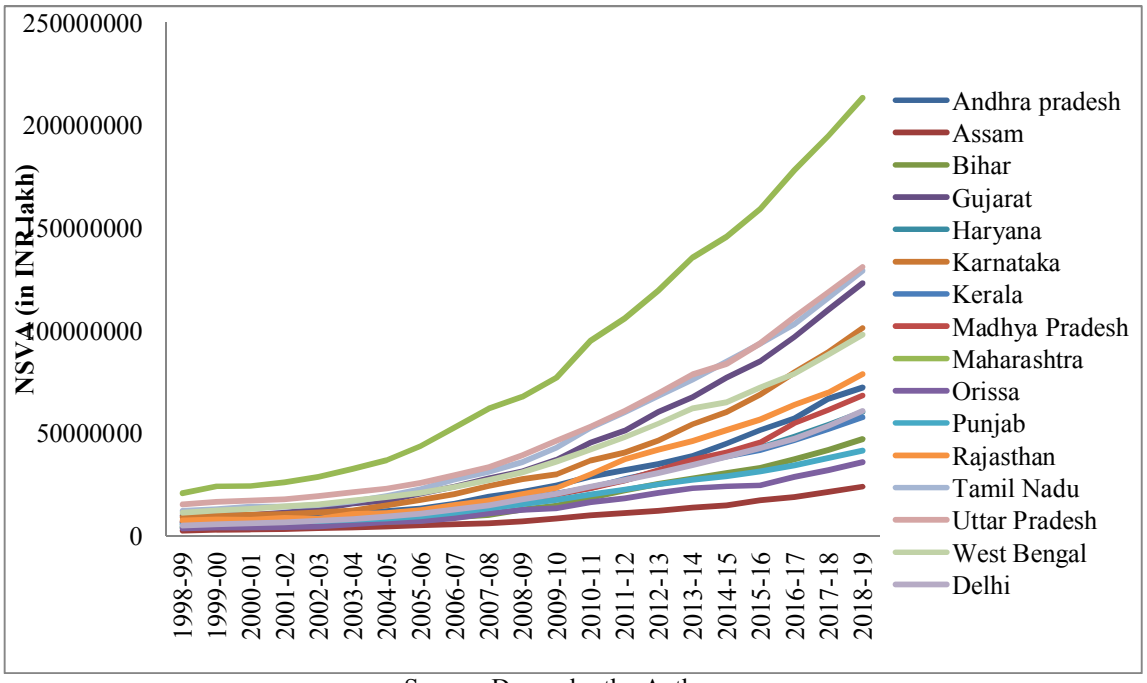
6.3. Vector Error Correction Model (VECM) estimation and Wald Test

After the confirmation of the prevalence of cointegration among the variables, the short run dynamics is investigated by means of VECM. VECM also indicates the speed of adjustment in the deviations. And finally, short run causal interplays are done by Wald test.

7. Empirical Results and Discussion

Before moving for proposed econometric exercises, the study presents the data on NSVA and HCI in two sets of line diagrams for each to have ideas about their trends at a glance. Figure 1 and 2 show NSVA and Figure 3 and 4 show HCI.

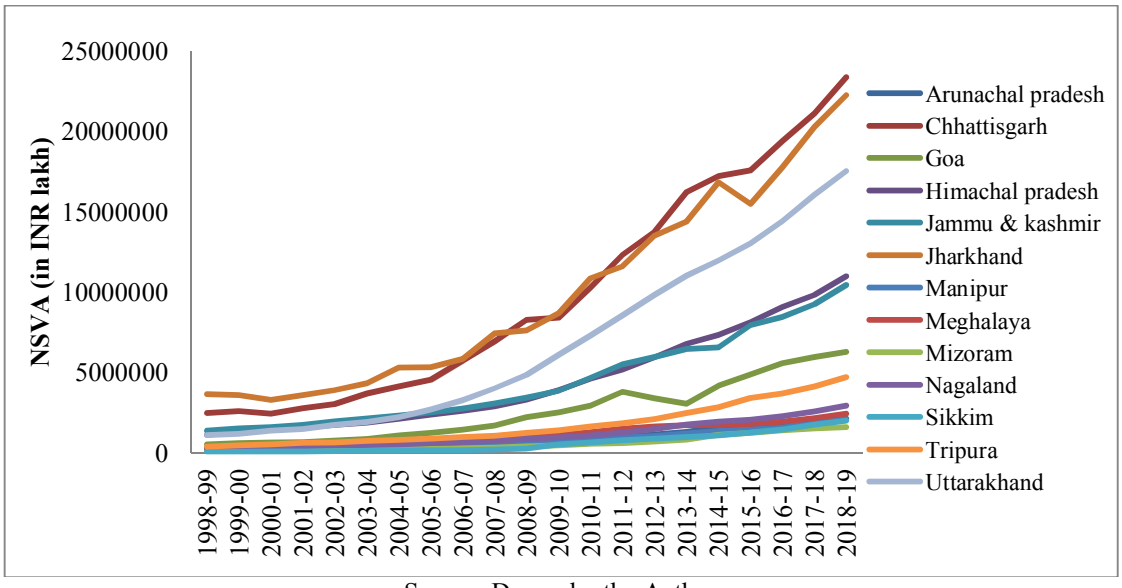
Figure 1. Trends of NSVA for the leading states in India



Source: Drawn by the Authors

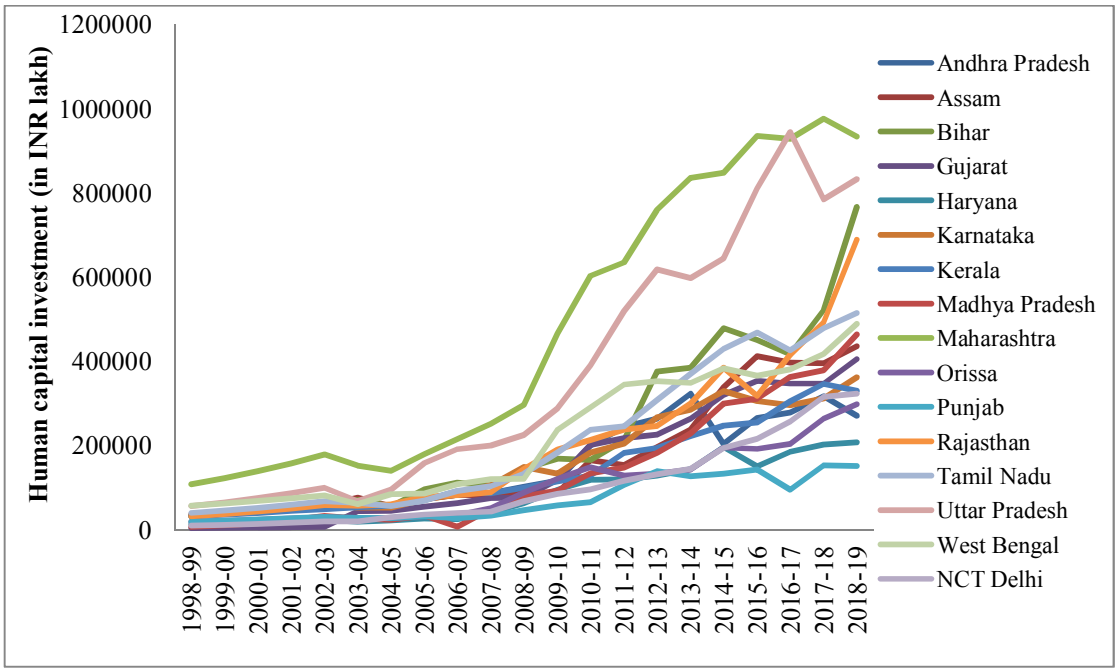
It is seen from Figure 1 and 2 that the trends of NSVA are increasing for all the states. Maharashtra leads the group followed by Uttar Pradesh and West Bengal. On the other hand, Sikkim is at the bottom level preceded by Mizoram and Meghalaya.

Figure 2. Trends of NSVA for the follower states in India



Source: Drawn by the Authors

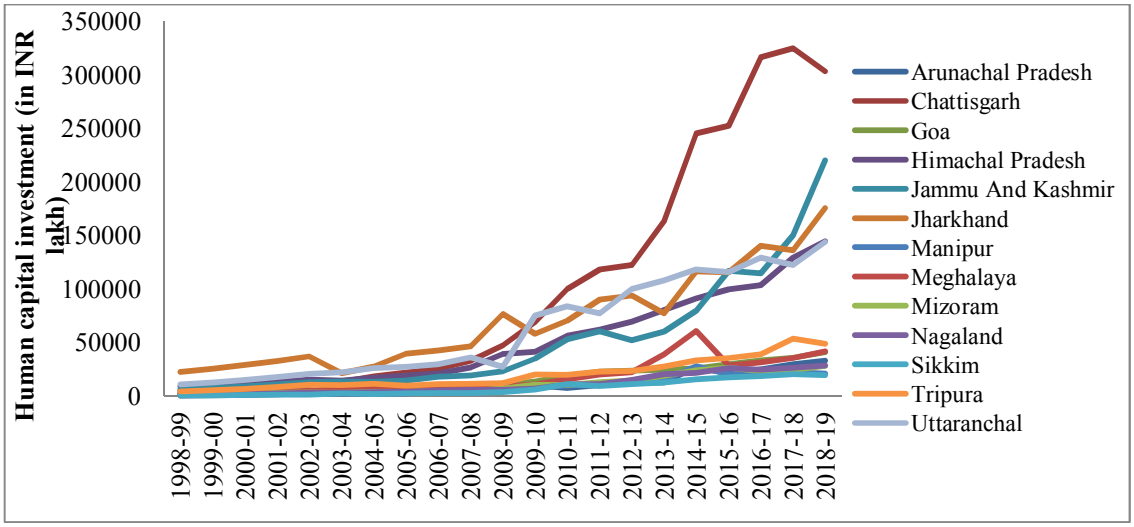
Figure 3. Trends of HCI for the leading states in India



Source: Drawn by the Authors

It is observed from Figure 3 and 4 that the trends of HCI are increasing for all the states in India. Maharashtra still holds the top position followed again by Uttar Pradesh and West Bengal. On the other hand, Sikkim stays at the bottom preceded by Nagaland and Meghalaya.

Figure 4. Trends of HCI for the follower states in India



Source: Drawn by the Authors

Comparing the figures 1 to 4, it can be said that the incomes of the states are associated with their human capital investment, the sum of education and health expenditures by their governments. The study thus goes for investigating the interrelationships between income and HCI in the panel of the states and union territory.

In this section the study presents the results of panel unit roots to Wald test as mentioned in the methodology section.

7.1. Panel unit root test results

The study finds that the series belonging to NSVA and HCI are non stationary in their level values and they are converted to stationary series after taking their first differences. The upper part of Table 1 reports the results of panel unit root test for NSVA and the lower part is that of the HCI.

Table 1. Panel unit root test results

Series: D(NSVA)				
Hypotheses	Methods	Statistic	Prob	Obs.
H_0: Presence of unit root (Assuming common unit root)	LLC t* test	-8.74679	0.0000	535
	Breitung's t-stat	0.84097	0.7998	506
H_0: Presence of unit root (Assuming individual unit root)	IPS W-stat	-8.58389	0.0000	535
	ADF-Fisher χ^2	184.198	0.0000	535
	PP- Fisher χ^2	243.912	0.0000	551
H_0: No unit root (Assuming common unit root)	Hadri Z-stat	6.76786	0.0000	580

Series: D(HCI)				
Hypotheses	Methods	Statistic	Prob	Obs.
H_0: Presence of unit root (Assuming common unit root)	LLC t* test	-12.4961	0.0000	527
	Breitung's t-stat	-0.49152	0.3115	498
H_0: Presence of unit root (Assuming individual unit root)	IPS W-stat	-13.0258	0.0000	527
	ADF-Fisher χ^2	265.708	0.0000	527
	PP- Fisher χ^2	310.737	0.0000	551
H_0: No unit root (Assuming common unit root)	Hadri's Z-stat	8.82052	0.0000	580

Note: Automatic lag selection is based on SIC: 0 to 3

Source: Authors' calculations

The null hypothesis of 'no cointegration' is rejected in the case of first differenced series which implies, as per majority of the results, both the series are first difference stationary making the series to be I(1).

7.2. Lag length selection results

It is also a precondition to compute the optimum lag of the two series before going for further time series econometric exercises such as cointegration and causality analyses in a panel data. There are many criterions of selecting optimum lags, mostly used criterions are Schwarz Information Criterion (SIC), Akaike Information Criterion (AIC), and Hannan-Quinn Information Criterion (HQIC). The present study derives the optimum number of lags on the basis of AIC, SIC and HQIC. The results are given in Table 2. It is observed that two criteria, SIC and HQIC, give lowest values at lag four which means the influence of the variables of four years lag is significant upon the current period's values of the variables in the panel.

Table 2. Lag length selection criteria

Lag	AIC	SIC	HQIC
0	63.22600	63.24961	63.23543
1	54.78938	54.86020	54.81766
2	54.73871	54.85674	54.78584
3	54.67161	54.83685	54.73760
4	54.57171	54.78417*	54.65656*
5	54.57112	54.83079	54.67482
6	54.58097	54.88785	54.70352

Note: * implies lag order pointed out by the noted criteria.

Source: Authors' calculations

7.3. Panel cointegration test results

The study presents the results of cointegration in the selected panel data using the methods mentioned above which are the Pedroni test, Kao test and Fisher Johansen test. For the Pedroni test and Kao test, the results are derived using individual intercepts. The results are given in Table 3.

Table 3. Panel cointegration test results

Name of the test	Category of the test	Statistic	Probability
Pedroni test (Individual intercept)	Panel v-stat.	12.91524	0.0000
	Panel rho- stat.	-1.44553	0.0742
	Panel PP- stat.	0.789887	0.7852
	Panel ADF- stat.	-4.33163	0.0000
	Group rho- stat.	-2.89984	0.0019
	Group PP- stat.	-4.21197	0.0000
	Group ADF- stat.	-2.66644	0.0038
Kao test	ADF- stat.	0.427674	0.3344
Fisher (Combined Johansen) test	Fisher stat.	485.8000	0.0000
	Fisher stat. (Max. Eigen value)	395.3000	0.0000

Source: Authors' calculations

Pedroni test has seven diverse statistics. Out of them, the first four are within-dimension and the remaining three are for between-dimension estimates. The majority of the test statistics under Pedroni test reject the hypothesis of 'no cointegration'. It implies both the panels of the variables, NSVA and HCI, maintain an equilibrium or long-run relationship among them. Further, the Kao ADF-Statistic does not reject the hypothesis of 'no cointegration' implying no long run relations among the variables in the panel data. But the cointegrating relation among the variables has been shown by Fisher combined test.

Considering the results of all the test statistics, the majority of the results reject the hypothesis of 'no cointegration'. Therefore, the study arrives at the conclusion that the two unit root variables NSVA and HCI are cointegrated. In other words, there is the presence of long run association among economic prosperity and the human capital investment in the panel of the states and UTs in India. The budgetary expenses of the state governments in India upon education and health sectors have anyway maintain co-movements with their incomes. It is a good sign so far as the motives of the state governments towards generation of human capitals are concerned. We thus move to our next step of investigations, the VECM.

7.4. Estimation through VECM

With the objective of examining the dynamics of the associations observed in long run in the panel of states/UTs with respect to income and human capital formation, the VEC model is constructed for the lag of four years (refer to Table 2) in the following way-

18.

$$\Delta NSVA_t = C(1) + C(2)\,\Delta(NSVA)_{t-1} + C(3)\,\Delta(NSVA)_{t-2} + C(4)\,\Delta(NSVA)_{t-3} + C(5)\,\Delta(NSVA)_{t-4} + C(6)\,\Delta(HCI)_{t-1} + C(7)\,\Delta(HCI)_{t-2} + C(8)\,\Delta(HCI)_{t-3} + C(9)\,\Delta(HCI)_{t-4} + Cons.$$

The estimated VEC model is:

19.

$$\Delta(\hat{NSVA})_t = \underset{Prob:}{0.1147} + \underset{(0.0000)}{0.1472}\,\Delta(NSVA)_{t-1} + \underset{(0.0078)}{0.0142}\,\Delta(NSVA)_{t-2} + \underset{(0.8039)}{0.2236}\,\Delta(NSVA)_{t-3} + \underset{(0.0002)}{0.1580}\,\Delta(NSVA)_{t-4} + \underset{(0.0124)}{11.0041}\,\Delta(HCI)_{t-1} + \underset{(0.0000)}{9.5984}\,\Delta(HCI)_{t-2} + \underset{(0.0000)}{2.0397}\,\Delta(HCI)_{t-3} + \underset{(0.3904)}{7.0195}\,\Delta(HCI)_{t-4} + \underset{(0.0056)}{1826762}\,\underset{(0.0000)}{}$$

The coefficient of $\hat{\varepsilon}_{t-1}$ is found to be positive and statistically significant. Prevalence of the result of positive coefficient of $\hat{\varepsilon}_{t-1}$implies that the divergence from the equilibrium will persist and the relationships among the variables will be temporary, other variables may work in the interim other than the human capital to justify the growths of incomes of the states. Such diverging relations will further imply that there will be no causal effects from human capital to income in the long run framework. But there can be short run causal interplays among the variables. Here the coefficient of ΔHCI such as C(6), C(7), C(8) and C(9) give the indications of short-run causal relationships between investment upon human capital and output of the states and UTs. The derived results through Wald test (Table 4) show that the individual coefficients of the regressions are significant statistically which show the occurrence of the causal influence from investment upon human capital to economic output in the short-run as the value of the Chi-square statistic is 35.67 with very low value of the probability.

Table 4. Wald test results

H_0:C(6) = C(7) = C(8) = C(9) = 0 [No short-run causality running from HCI to NSVA]			
Test Statistic	Value	df	Probability
Chi-square	35.66898	4	0.0000

Source: Authors' calculations

Further, the three coefficients of the lag terms of HCI, C(6), C(7) and C(9), are found to be positive and significant. They present the degree of influence of the human capital formation upon the incomes of the panel of the states/UTs. One unit rise in the change of HCI in the last year makes to 11 unit rise in the change of state incomes of the current year. The value for lag 2 is 9.6 and for lag 4, it is 7. Therefore, the impacts of 1-4 years' lag in the human capital are observed to be significant upon the current period's incomes of the states and UTs.

7.5. Linkage with intellectual capital and regional policy practices

The results so far are justified to conclude that the human capital generated in the states and UTs in India is one of the sources in the increases in the incomes of the states and UTs as it has associations with the incomes of the states/UTs at least in the short run with respect to its significant causal influences to the incomes. A large population size in India like countries should not be considered as the negative items to the growth of income as the neoclassical growth model claims. It rather helps in generating extra demand in one side and generating human capital through government supported education and health initiatives. Once the stock of human resource is sufficiently generated by means of school and higher levels education and increasing life expectancy, reducing infant mortality rates, etc. then there can be automatic generation of intellectual/knowledge capital. Although the nature of human capital is somewhat private and rivalry in nature, the knowledge capital or R&D (research and development) is mostly public in nature with non-rivalry and non-excludability features. Therefore, the chain of effects, in the long run, human capital formation→ knowledge capital formation→ positive per capita income growth, can be expected to work and the country as a whole will be benefitted in terms of attaining the true stage of development. The governments of the states and UTs are, therefore, recommended to make further investments in the sectors, such as education and health, to ensure better economic growths of them.

Formation of good human capital is not only helpful for a country in terms of economic progress, it can also be a good content for development so as to maintain sustainability at the global level. If the countries focus in this area to strengthen their human capital base by means of research and development activities, good innovation practices, the volume of good quality human capital will increase leading to good use of environmental resources, save the nature and promoting the achievement of sustainable development. So, the leaders at the global level as well as the regional levels should focus upon developing human capital base through proper collaborations and participations.

8. Conclusion

Human capital is, without a doubt, one of the most significant components of production function in the today's world so far as the development of the endogenous growth theories are concerned. Human capital investments tend to boost the efficiency and productivity of an

economy's existing labour force; hence it's often linked to the growth of the economy. Improved human capital, as it is generally contended, leads to increased level of economic output and side-by side, output expansion leads to human capital formation. Thus, the present study aimed to examine whether there could be empirical evidences on the co-movements or associations among investment in human capital and economic output for panel of states/UTs of India during the period from 1998-99 to 2018-19. In this regard the study applied panel cointegration technique to show long run association and then used Wald test to show the short run direction of causal interplay between human capital investment and economic output. The empirical results show that there arises a long run association among human capital formation and economic progress. Employing Wald test, it is also found that a short run association between human capital and economic output exists and the causality is in the direction from human capital investment to economic output. i.e., economic progress is influenced by human capital instantly. Keeping the merit and depth of the findings, the study, therefore, recommends that the governments of the states and UTs should make further investments in the sectors, such as education and health, to ensure better economic growths to their economies in the long run.

9. Limitations and Future Directions of the Study

The present research, although covers the panel of the states and union territories of India, considers government spending on the sectors such as health and education as the key variable for human capital formation and its implications to state outputs. But the study could be better if it could consider human capital stock such as number of literate persons, number of higher educated persons, life expectancy, child care, health care, etc. Again, the study could also focus on the linkage among human capital and intellectual capital and their implications with state and territorial incomes. The present study restores all of the undone works as its future research agenda.

10. Practical Implications

The study so far with the results have strong practical significance with the public operating systems of India in its states and territorial levels in the heads of education and health in particular, and human capital in general. Higher representations of the total population in education sector and good quality health through proper infrastructural development will be the key to India's future. The study can be applicable to other countries as well. All the governments at the provincial and territorial levels in each country should focus on this area to out-progress the peers at the global level.

11. Authors' Contributions

The entire work is the outcome of combined effects. The second author has provided the theoretical and empirical ideas, constructed the theoretical model, relate the work with intellectual capital, and edited the entire work. The first author has intervened in literature review, empirical methodology and empirical estimations.

12. Disclosure Statements

It is declared that the authors did not face any conflict of interests with anybody while developing the full paper. Also, it is disclosed that there was no funding agency behind the work, and there was no use of animals/human beings in the work.

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