From healthcare to wealthcare: assessing the impact of public health spending on economic growth in Indian states

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Abstract

Purpose – This study investigates the long-run relationship between public health expenditure and economic growth across 15 major Indian states over the period 1981–2022, with a particular focus on the health-led growth hypothesis and the reciprocal dynamics between healthcare investment and economic performance.

Design/methodology/approach – The study employs advanced panel econometric techniques that account for cross-sectional dependence and heterogeneity. Second-generation panel unit root tests (CIPS) are used alongside Kao, Pedroni and Westerlund cointegration tests to establish long-run relationships. The common correlated effects mean group (CCEMG) and common correlated effects pooled (CCEP) estimators are applied to estimate long-run elasticities while controlling for variables such as unemployment rate, labour force participation, population growth, public debt and female education.

Findings – The results confirm a strong long-run cointegrating relationship between public health expenditure and economic growth. Public health spending and labour force participation rate emerge as key drivers of economic performance, both showing statistically significant and positive effects. Specifically, increases in health expenditure contribute positively to state-level economic growth, while higher labour force participation further strengthens growth outcomes. Other control variables exhibit expected signs but are generally less significant.

Originality/value – This study contributes to the literature by providing a comprehensive state-level analysis for India using second-generation panel techniques that explicitly address cross-sectional dependence and non-stationarity. It advances existing research by integrating multiple cointegration approaches and employing CCE estimators to capture unobserved common factors and regional heterogeneity.

Keywords Cross-sectional independence, Healthcare spending, Economic growth, Cointegration

Paper type Research article

1. Introduction

According to endogenous growth models (Romer, 1990), human capital is essential to economic growth and development. Economic development is significantly influenced by factors such as population health, education which raises productivity and, consequently, per capita income. A significant portion of the previous research on economic growth considers the expansion of the labour force and the physical capital assets. As per HLG (Health Led Growth Hypothesis) (Mushkin, 1962), the expenditure on healthcare can stimulate economic growth as health is a determinant of it. Barro (1996) asserts that good health may be both a source of capital and a spur to economic expansion. Grossman (1972) and Bloom and Canning (2000) describe how people in sound health are better at assimilating information and, as a result, are more productive. Health [1] is a sort of capital, according to this idea. Thus, healthcare spending has the potential to increase incomes and stimulate the economy. The

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accumulation of human capital, which is fuelled by healthcare investments, is a crucial element of the endogenous growth model. In order to develop human capital, healthcare policy and innovative methods are very important. Therefore, investment in healthcare that drives economic expansion is hence a pivotal modern research focus.

Nevertheless, earlier works they were unable to clarify how labour growth and GDP growth are related. Because worker productivity is directly correlated with economic growth, it makes sense that healthier workforces would be able to work longer and produce more. Additionally, improved health has a positive impact on educational attainment and learning capacities and develop new skills, which boosts the effectiveness of human capital. The more efficient and more skilled human capital is essential for driving economic growth in an economy.

Since the implementation of new economic reforms, the real GDP (gross domestic product) per capita of India growth rate has been steadily increasing, with annual fluctuations. The health indicators have been also improving although these are still high [2]. In addition to accelerating economic growth, public health spending also improves health indicators. It is imperative to evaluate the influence of healthcare expenditure on India's economic expansion.

Many studies have examined how economic growth affects healthcare spending. However, there has been a recent surge in interest in the influence of healthcare spending on growth. There are still controversies going on among the researchers on the growth-led hypothesis (Kleiman,1974; Misra and Panda, 2007; Mays and Smith, 2011) and health-led growth hypothesis (Barro, 1996; Hansen and King, 1996; Clemente *et al*., 2004). Some researchers find an endogenous relationship healthcare expenditure and real economic activities (Hamoudi and Sachs, 1999). A few studies fail to discover a substantial correlation between healthcare spending and the economic expansion (Mehrara, 2011). Thus, policymakers must examine how public health spending affects economic growth in India [3].

Furthermore, most emerging economies have witnessed increased public spending over the years. According to Anand and Ravallion (1993), these countries should focus particularly on the link between economic expansion and government health spending, as well as the effect that this has on health outcomes. In both developed and developing nations, there has been limited investigation into the causal link between government expenditure at the state and regional levels and the growth of GDP. Therefore, it is essential for India to investigate the enduring impacts of public health expenditure on economic performance [4].

Health is a fundamental aspect of human well-being, influencing every facet of life, including economic productivity. Health and economic productivity are interdependent, and recently, this connection has seen considerable growth. Countries realizing how important health is in determining human capital and economic output. Government worldwide are raising their expenditure of healthcare infrastructure and facility. The government plays a critical role in promoting population health and increasing economic productivity through targeted healthcare expenditures under various schemes and programs designed to ensure access to affordable and high-quality medical care services for all citizens, regardless of income or culture. In India the Government has introduced many flagship healthcare initiatives (National Health Rural Mission (April 12, 2005), National Urban Health Mission (2013), Pradhan Mantri Surakshit Matritva Abhiyan (2016), Mission Indradhanush (2014), Ayushman Bharat- Pradham Mantri Jan Arogya Yojana (September 23, 2018), Poshan Abhiyaan (2018), National Digital Health Mission (2020), etc.). These health schemes mainly have the aim to improve healthcare expenditure, expanding coverage and reducing out of pocket expenditures, to attain the sustainable development goals (SDGs).

Focusing on India's regional administrations, this study examines the detailed links between healthcare investment and economic progress. This enquiry endeavours to reveal the vital role that public health spending plays in promoting sustainable development and wealth creation at regional levels by closely examining how resources are allocated to healthcare initiatives and how those initiatives affect GDP growth. It aims to shed light on how a healthier population improves life quality and stimulates economic growth through extensive data analysis and empirical research. This highlights the paradigm shifts from the provision of healthcare alone to a more comprehensive definition of “wealthcare,” which includes wealth creation and health as intertwined aspects of societal advancement.

There are four domains in which our study is different from previous research. This paper has methodological advancement over the earlier studies. First, this study examines healthcare spending and real economic expansion cointegration and non-stationarity. To support cross-sectional correlations, we applied second-generation panel unit root tests (SGPU). Furthermore, we used Westerlund’s (2007) cointegration test, which follows a normal distribution and allows for a wide range of heterogeneity. In addition, we used Pesaran (2006)’s common correlated effects pooled (CCEP) and mean group (CCEMG) estimators [5]. Secondly, we have compiled comprehensive and up-to-date data for 15 major Indian states spanning the years 1981–2022. Third, a few empirical studies (Misra and Panda, 2007; Panda and Panda, 2013) in India have investigated how public health spending affects economic growth. These studies did not consider the cointegration and non-stationarity of Indian health expenditure and economic growth. Thus, a systematic study of the long-term effect of health expenditure on real economic activity is crucial for policy. Fourth, we investigate how healthcare spending affects economic growth after controlling for regressors such as the female gross enrolment ratio, unemployment rate, labour force participation rate, population growth and outstanding liabilities.

Subsequent sections comprise the other part of the paper. Section 2 provides the evidence of healthcare in India and overseas. The analytical structure is discussed in Section 3 Section 4 addresses data and estimating technique; Section 5 addresses econometric model respectively. While Section 7 offers policy recommendations, Section 6 analyses the empirical findings.

2. The evidence of healthcare spending in India and overseas and the rationale for the study

Table 1 presents the decade-long annual average of healthcare expenditure indices alongside the economic performances of eleven nations—Brazil, China, France, India, Italy, Japan, the Russian Federation, Singapore, South Africa, the United Kingdom and the United States. The investigation attempts to provide light on the connections between healthcare spending trends and each nation’s economic performance. The percentage of current health expenditure

Table 1. International evidence of healthcare spending and economic performance

Indicators/ Countries	DPHE	CHE	DGHE	OPE	GDP growth (annual %)	GDP per capita growth (annual %)
Brazil	56.77	8.88	3.82	26.10	0.36	−0.46
Russian Federation	38.56	5.45	3.37	36.05	1.32	1.07
India	69.95	3.27	0.95	60.15	5.20	3.96
China	43.28	4.95	2.81	36.70	6.84	6.27
South Africa	41.04	8.09	4.53	6.30	0.85	−0.43
United States	48.87	16.66	8.53	11.62	1.70	1.00
United Kingdom	19.19	10.01	8.09	15.51	0.71	0.04
France	26.82	11.42	8.36	9.77	0.47	0.09
Italy	24.97	8.84	6.64	22.78	−0.79	−0.82
Japan	15.97	10.70	9.00	12.86	0.38	0.52
Singapore	54.00	4.15	1.94	32.10	3.15	1.98

Note(s): Table 1 comprises the entirety of the World Development Indicator data from 2011 to 2020, as reported by the World Bank. The figures are the average annual value over the past decade. DPHE indicates domestic private health expenditure (percentage of current health expenditure), CHE indicates current health expenditure (percentage of GDP), DGHE indicates domestic general government health expenditure (percentage of GDP) and OPE indicates out-of-pocket expenditure (percentage of current health expenditure) financed by private sources in each country is shown by domestic private health spending. Brazil and India show the highest reliance on private financing for healthcare with 57% and 70% respectively. The current health expenditure (% of GDP) quantifies total healthcare spending relative to each country's economic output. The United States allocates the highest percentage of GDP to health expenditure followed by France and Japan. India and Russia have relatively lower percentages, indicating a smaller share of GDP dedicated to healthcare. The percentage of domestic general government health expenditure relative to GDP highlights the proportion of government-funded health spending in relation to the overall economy. Japan, the United Kingdom and France allocate significant portions of GDP to government health expenditure while India has a notably lower percentage of government contribution to healthcare. Out-of-pocket expenditure represents the proportion of health expenditure paid directly to individuals. India and China exhibit high out-of-pocket expenditures indicating a significant financial burden on individuals. GDP growth rates vary among the countries, with China consistently showing high growth rates followed by India. Japan and Italy demonstrate negative growth rates reflecting economic challenges. GDP per capita growth (Annual %) varies across countries, with China and India exhibiting relatively high growth rates; Brazil, South Africa and Italy on the other hand show negative growth rates indicating economic stagnation.

Since 2005, India's total health expenditure as a percentage of GDP (THE%) has stayed under 4.5%. the %GDP was 4.2% in the year 2004–05 which further declined to 3.8% during 2016–17. This had further fell down to 3.2% during 2018–19. The capital expenditure as percentage of GDP remained below 1% during 2005–2020. It is interesting to note that, compared to other developed nations of the world, India's overall health spending as a share of its GDP has stayed low since last 20 years. The health statistics in India are still high, but they are constantly getting better. In India, the rates of infant and child mortality (per 1,000 live births) are steadily improving. The neonatal mortality rate was 48.6 in the year 1992–93 which fell down to 43.4 in the year 1998–99. It again declined to 43.4 and further to 39 during 1998–99 and 2005–06 respectively. There was a drastic fall in the neonatal mortality rate, i.e. 24.9 in the year 2019–21.

Similarly, the infant mortality rate (IMR) of India was 78.5 in the year 1992–93 which further declined to 67.6 and 57 in the year 1998–99 and 2005–06 respectively. In the year 2015–16, the IMR further declined to 41 and thereafter in the year 2019–21, it again fell down to 35.2. The under-five mortality rate has been also steadily falling down since 1992–93. The under-five mortality rate declined to 94.9 in the ear 1998–99 from 109.3 in the year 1992–93. It was 74.3 in the year 2005–06 which further fell down to 50 during the period 2015–16. There is also a greater fall in the under-five mortality rate to 41.9 in the year 2019–21. The GDP per capita has been also continuously rising with yearly fluctuations since 1992–93. The maternal mortality ratio of India has been continuously falling since 1997–98. The maternal mortality rate fell down to 212 during 2007–09 from 398 during 1997–98. During the year 2016–18, the maternal mortality ratio slightly fell down to 113.

The birth life expectancy was 60.7 years and increased to 65.7 in 2005. In 2018, the birth life expectancy rose even higher to 69.3 years. Overall, infant mortality, maternal mortality and life expectancy have improved since the 1990s. The growth rate in GDP per capita has been also rising since 1990s with yearly fluctuations. From the above discussion, we conclude that health statistics although still high, continuously improving since last 30 years. Similarly, the GDP per capita has been also rising since last 30 years in India. Public health spending and real GDP growth were positively correlated in India from 1981 to 2022. Therefore, it is essential to know how healthcare expenditure affects Indian economic development. Increasing the health expenditure and thereby improving the health indicators could be instrumental to achieve sustained high economic growth rate.

3. Analytical framework

The expenditure on healthcare is the catalyst for sustained high economic growth, as assumed in earlier health-led growth literature (Mushkin, 1962; Barro, 1996; Grossman, 1972; Bloom and Canning, 2000). Healthcare expenditures boost economic growth by reducing absenteeism and improving worker health. It also fosters advancements and innovation in technology in the healthcare sector, which leads to the development of emerging markets and products. By investing in preventive healthcare interventions, countries can alleviate the financial burden of treating advanced maladies and allocate resources to more advantageous purposes. In addition, equitable access to healthcare services promotes social welfare and reduces inequality, thereby fostering a more sustainable and inclusive economic growth trajectory. Therefore, the anticipated impact of healthcare expenses upon the economy is favourable.

High levels of unemployment, particularly disguised unemployment, have always been an endemic social ill in a developing economy such as India. A decrease in income in the hands of individuals leads to a fall in money saved, a lower in capital formation and a drop in productivity as unemployment increases in an economy. The unemployment rate is indirectly correlated with the economic rate of growth. Economic output will diminish by 2% in response to a 1% increase in the unemployment rate (Higgins, 2011). Therefore, it is envisaged that the unemployment rate will exhibit a negative coefficient sign.

Expanding the labour force through population growth can boost economic growth by raising levels of production and consumption (Motkuri *et al*., 2019). In addition to increasing demand for products and services, a growing population also encourages investment and entrepreneurship. Unchecked population expansion, however, may put a burden on the environment, infrastructure and resources, which could impede economic growth. By combining population growth's advantages and disadvantages, family planning, healthcare and education programs that work can foster sustainable economic growth. Thus, we expect that population growth will have a positive coefficient sign.

The workforce is an essential driver of economic development since it embodies a nation's productivity. With the expansion and enhancement of the work force, there is a potential for a rise in productivity, innovation and the total economic output. Therefore, it is expected that a rise in the workforce would enhance the pace of economic growth.

Growing government debt is a result of the government's increased expenditure, which also widens the fiscal imbalance (Bal and Rath, 2014). According to certain endogenous growth research and neo classical economists, government debt has a negative long-term effect (Saint-Paul, 1992). However, several studies show that debt has no negative effect on growth (Panizza and Presbitero, 2014). Economic growth and population growth have a complex relationship that varies according to resource availability, technological innovation and economic development stage. As a result, the coefficient estimate for debt outstanding is likely to be ambiguous.

For a nation to develop, education is essential. The place of women in economic development is growing every day. The essential component of progress is women. The economic success can be attributed to women's contributions to education and development processes. The rise in child health and decline in fertility rates, which lessen domestic violence and empower women to make decisions about their families. To advance education, a plan for education was created along with a national education policy, a comprehensive action plan with numerous measures was formulated to encourage higher education and the literacy rate. Thus, the coefficient sign of female gross enrolment ratio is expected to be positive in the model.

From the above discussion, the following functional form is developed.

$$lgsdp = f(lhe, ur, ldebt, lfpr, popgr, fger)$$

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where the log of gross state domestic product is denoted by *lpgsdp*. *ldebt* is used to present the log of debt outstanding, while *lhe* represents the log of public health expenditure and ur is the unemployment rate. The female gross enrolment ratio is denoted as *fger*, population growth is denoted by *popgr* and the labour force participation rate is expressed as *lfpr.*

4. Data

The purpose of this study is to examine the long-term relationship between healthcare expenditure and economic growth in 15 major Indian states from 1981 to 2022. Healthcare expenditure data, which encompasses family welfare, medical and public health expenses, was sourced from the EPWRF (Economic and Political Weekly Research Foundation) database. Variables such as per capita state domestic product (*lpsdp*) and healthcare expenditure (*lhe*), which are measured in rupees in lakhs, are both converted to log. The unemployment rate, which is equal to the number of unemployed individuals divided by the total workforce, is quantified by the variable *ur.* This data is derived from the EPWRF database. The labour force participation rate (lfpr) quantifies the share of the working-age population, defined as individuals aged 16 and older, who are either actively pursuing employment or not currently enrolled in educational institutions. The variable debt is a metric that quantifies the total quantity of outstanding debt, which is expressed in lakhs of rupees and encompasses both the principle and interest that must be paid. Popgr measures population growth, which is proportional to the birth rate minus the mortality rate divided by the initial population size. The EPWRF database is the source of all variables.

Table 2 shows selected variable summary statistics. Over the period 1981–2022, all Indian states spent less than 1% of their GSDP (gross state domestic product) on healthcare. The last ten years average of the real economic growth rate of the Indian states is hovering between 4 and 9%. Gujarat has the highest percentage of GSDP growth rate (i.e. 8.6%) while West Bengal has the lowest (i.e. 4.6%). West Bengal, Kerala, Maharashtra, Punjab, Uttar Pradesh, Rajasthan and Bihar experienced 6% or less growth, whereas other major Indian states such as Andhra Pradesh, Tamil Nadu, Assam, Odisha, Madhya Pradesh, Haryana, Karnataka and Gujarat experienced more than 6% annual average GSDP growth from 2011 to 2022. The overall trends in the GSDP growth rate and the healthcare expenditure are portrayed in Figure 1 for the period 1981–2022. The scatter plots of the healthcare spending and economic growth rate for all selected states are presented in Figure 2. The scatter plots clearly show a significant positive relationship between public health expenditure and India’s economic growth rate from 1982 to 2022. Figure 3 illustrates the scatter plots of 15 prominent Indian states, demonstrating a significant and robust association between healthcare expenditure and economic expansion. Further, the heat plot in Figure 4 identifies no high correlation among the regressors and hence, gives evidence of the absence of an autocorrelation problem.

5. Estimating technique and econometric model

This study shows India’s long-term healthcare spending and economic growth. The model used in the analysis:

Table 2. A brief statistical overview of the important variables

Variable	Obs	Mean	SDEV.	Min	Max
lpsdp	630	10.66	0.68	9.19	12.18
lhe	630	8.17	2.13	0.00	13.44
ur	630	3.06	2.23	0.40	11.90
lfpr	630	46.22	9.77	26.80	69.90
ldebt	630	5.59	1.71	1.85	8.79
popgr	630	1.75	0.48	0.50	2.50
fger	630	93.61	19.78	35.00	152.30

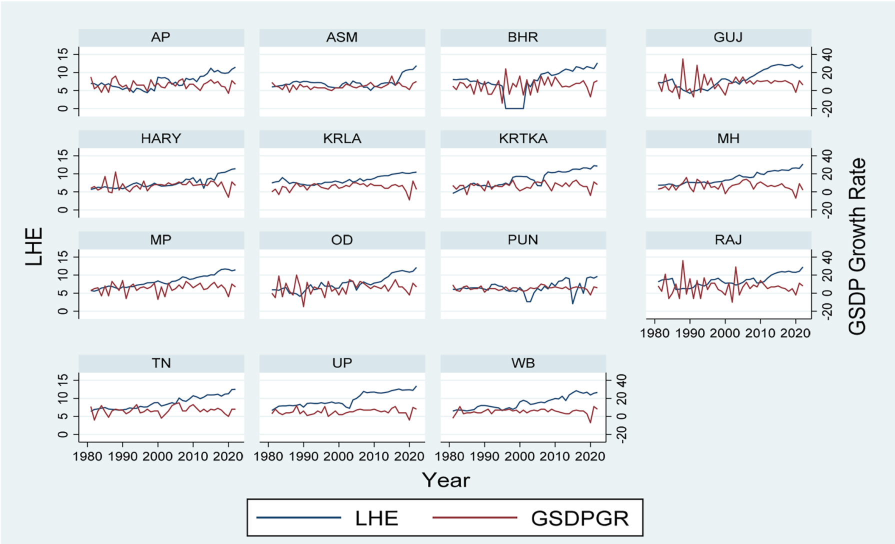

Figure 1. Trends in the GSDP growth rate and public health spending in Indian Subnational governments

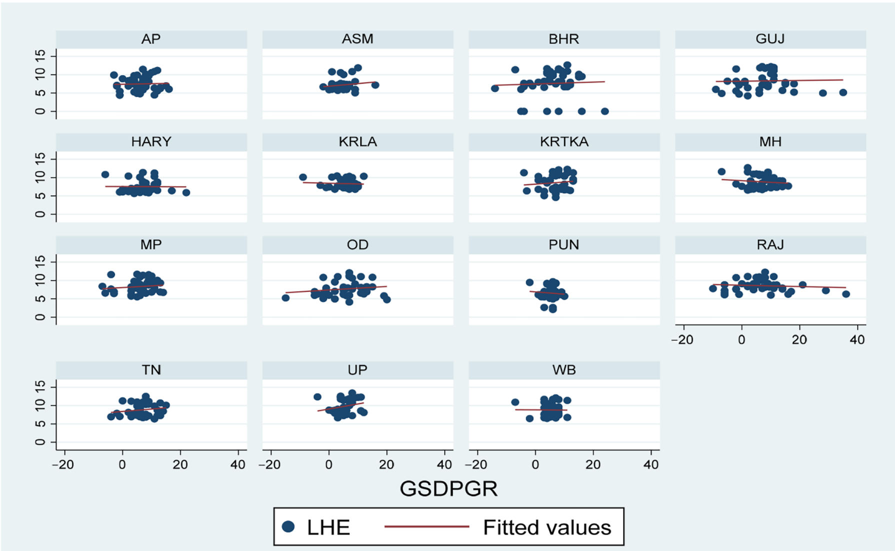

Figure 2. Scatter plots of the GSDP growth rate and public health spending in Indian Subnational governments

$$lpsdp = \alpha_i + \mu_i t + \gamma_i' x_{it} + \epsilon_{it} \tag{1}$$

For each state ($i = 1, 2, \ldots, N$) and time period ($t = 1, 2, \ldots, T$), the logarithm of real per capita income is represented by the symbol lpgsdp. Similarly, γ_i' is a $k \times 1$ set of explanatory

Figure 3. Scatter plots of the GSDP growth rate and public health spending in Indian Subnational governments for the period 1981–2022

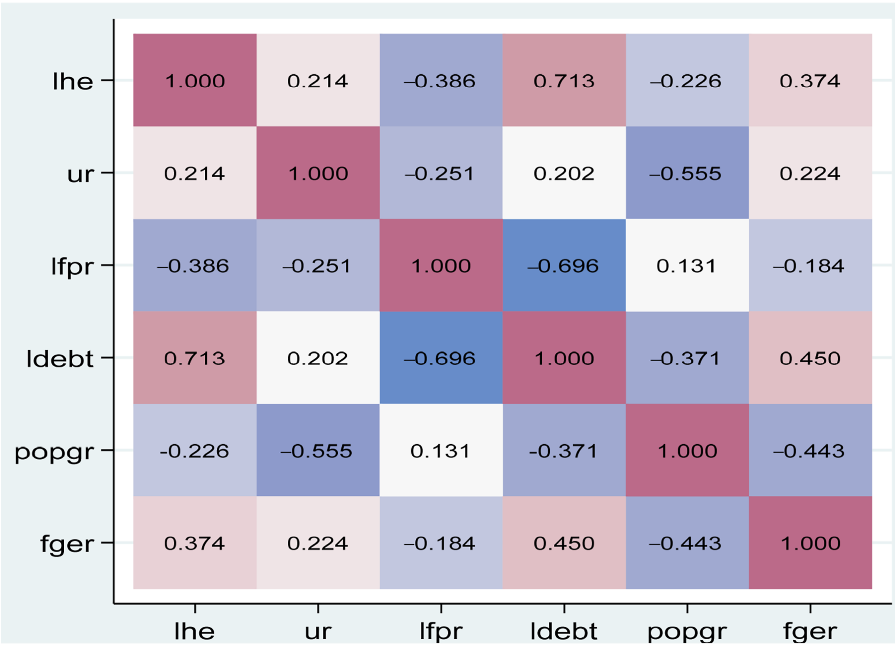

Figure 4. Correlation matrix

variables. α_i represents the state-specific effects, while $\mu_i t$ displays the heterogeneous state-specific deterministic trends. The following is the structure of the error term, i.e. ϵ_{it}.

$$\epsilon_{it} = \beta_i' f_t + u_{it}, \tag{2}$$

where the vector of unobserved common shocks is denoted by f_t. These shocks may have stationary or non-stationary serial correlation, according to Kapetanios *et al*. (2011). The explanatory variables found in Equation (1) may have a correlation with it. It is presupposed that the distribution of the state specific errors u_{it} is unaffected by the regressors and the unobserved common variables. These entities may manifest serial correlation and depend on one another over time.

We have used Pesaran's (2006) CCE estimators, which asymptotically remove dependencies between states. There are two estimation approaches available: CCEMG estimator and CCEP estimator. We followed the random coefficient model of Pesaran (2006) i.e. $\phi_i = \phi + \varpi_i$, where $\varpi \sim iid\,(0, v_{\varpi})$, we calculate ϕi's average value.

We seek measurable variables in cross-sectional research to represent unseen factors. The nonstationary panel technique uses state-specific deterministic α_i and $\mu_i t$ to capture a wide range of variables. Furthermore, ϵ_{it} encompasses variables that are difficult to quantify because of their unobserved common components.

6. Tests for stationarity and unit root

Our empirical study starts by identifying the unit roots of the selected variables. We have employed both the first and SGPU tests. In this case, correlations between different states are nuisance parameters. The presumption of independence among states is limiting and, to a certain degree, unrealistic. Additionally, the first generation unit root tests result in low power and size distortions because they fail to account for cross-sectional dependence (Banerjee *et al*., 2004; Strauss and Yigit, 2003).

This problem is addressed by the SGPU tests, which support CSC. These methods take advantage of co-movements rather than viewing correlations between units as bothersome factors. According to Quah (1994), the lack of natural ordering among individual observations makes it difficult and problematic to represent cross-sectional interdependence [6]. This analysis used Breitung (2001), Im *et al*. (2003) (IPS) and Pesaran (2007) CIPS panel unit root tests [7].

We consider the most popular IPS and Breitung panel unit test before discussing CD (cross-sectional dependencies). With state-specific deterministic temporal trends and state fixed effects, our model allows for some degree of heterogeneity for N countries and T time periods. The following is one way to write the model:

$$\Delta lpsdp_{it} = \alpha_i + \rho_i lpsdp_{it-1} + \sum_{k=1}^{p} \psi_{ik} \Delta lpsdp_{it-k} + \mu_i t + u_{it}, \tag{3}$$

where $t = 1, 2, \ldots, T$ and $i = 1, 2, \ldots, N$. u_{it} is the error term.

The IPS test is built on the idea of cross-sectional independence. The alternative hypothesis may cause some values to remain stable, so the test accounts for heterogeneity in ϕ_i. A possible formulation for the IPS-proposed model that incorporates individual effects and time trends is as follows:

$$\Delta lpsdp_{it} = \alpha_i + \rho_i lpsdp_{it-1} + \sum_{k=1}^{p} \psi_{ik} \Delta lpsdp_{it-k} + \mu_i t + u_{it}, \tag{4}$$

The alternate hypothesis of this model allows stationarity in certain series but not all. Whereas the IPS test pools data from all the N cross-section units, the LLC test runs unit root tests for each one of them. We estimate the IPS test statistic by averaging the Dickey–Fuller (DF) or augmented DF tests. The IPS test statistic is:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{\rho_i}, \tag{5}$$

where t_{ρ_i} is the individual $t - statistic$ for testing $\rho_i = 0$. Standardized IPS t-bar statistics are provided as:

$$W_{t-bar} = \frac{\sqrt{N}\left(\bar{t} - 1\Big/ N\sum_{i=1}^{N} E[t_{iT}(p_i, 0)/\rho_i = 0]\right)}{\sqrt{N^{-1}\sum_{i=1}^{N} var[t_{it}(p_i, 0)/\rho_i = 0]}}, \tag{6}$$

When calculating the variance and mean adjustment factors, the W_{t-bar} statistic explicitly considers the underlying ADF ordering, which improves its performance significantly in small samples.

By utilizing common time dummies, the LLC and IPS tests that have been previously mentioned address the problem of CD to a limited degree. According to IPS (2003), no residual serial correlation exists. The model can be expressed as follows:

$$\Delta lpsdp_{it} = \alpha_i + \rho_i lpsdp_{it-1} + \varphi_i \overline{lpsdp}_{t-1} + \varphi_i \Delta\overline{lpsdp}_t \sum_{k=1}^{p} \psi_{ik}\Delta lpsdp_{it-k} + \mu_i t + u_{it}, \tag{7}$$

where $\overline{lpsdp}_{t-1} = \left(\frac{1}{N}\right)\sum_{i=1}^{N} lpsdp_{it-1}$ and $\Delta\overline{lpsdp}_t = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\Delta lpsdp_{it}$. A group mean statistic is computed following the individual cross-sectional unit ADF (CADF) regressions and comparing it to the critical value. The mean of the CADF statistics is used to modify the IPS t-bar test that CIPS represents. The CIPS statistic can be written as:

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} t_i(N, T), \tag{8}$$

Similar asymptotic null distributions for each individual CADF statistic exist, and they are unaffected by factor loadings. However, their dependence on the same factor causes them to be corelated. Consequently, averaging individual CADF statistics can be created. An average of the individual CADF numbers can therefore be created. It is not possible to use CIPS statistics with the usual central limit theorem.

7. Examining cross-sectional dependence

To ascertain whether cross-sectional dependence (or CD) exists across specific states, we have executed the standard diagnostic test recommended by Pesaran (2004). The following formula provides the CD test statistic:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N-1}\widehat{\rho}_{ij}\right), \tag{9}$$

To calculate the CD statistic, average the pairwise correlation coefficients $\widehat{\rho}_{ij}$ of the OLS residuals from each ADF regression equation.:

$$\Delta lpsdp_{it} = \alpha_i + \mu_i t + \rho_i lpsdp_{i,t-1} + \sum_{k=1}^{p} \psi_{ik} \Delta lpsdp_{i,t-k} + u_{it}, \tag{10}$$

where the variables α_i, μ_i and ρ_i represent individual fixed effect, series trend and autoregressive coefficients. Different cross-sections may have different values for α_i and the lag order ρ_i.

The autocorrelation is eliminated by the summation terms incorporating lagged $\Delta lpsdp$.

The null hypothesis associated with the CD statistics posits cross-sectional independence. It follows a two-tailed standard normal distribution, expressed as $CD \sim N(0, 1)$.

8. Tests of panel cointegration

Pedroni (1999, 2001, 2004) proposed tests for panel cointegration that are conducted to find the presence of a long-term relationship between *lpgsdp* and *lhe, ur, lfpr, ldebt, popgr* and *fger*. Only a brief discussion of the tests will be made because they are outside the purview of this investigation. Panel cointegration serves the dual purpose of allowing for adequate variability between individual panel components and pooling data to identify the common long-run linkage.

Pedroni (1999) investigates the performance of seven alternative statistics on small samples and develops their asymptotic distributions in order to investigate the null hypothesis – that cointegration does not exist. We have used three *t* statistics derived from Modified Phillips–Perron (MPP), Phillips–Perron (PP) and Augmented Dickey–Fuller (ADF). In addition, we have used the test based on error correction suggested by Westerlund (2007) and the Kao (1999) test to determine cointegrating correlations among variables. Westerlund (2007) test follows normal distribution and it also allows for a variety of heterogeneities and also yield robust *p*-values when CD is present through bootstrapping. The aim is to evaluate the feasibility of rejecting the absence of error correction as the null hypothesis. Cointegration is indicated by the rejection of the null hypothesis.

9. Empirical results

Prior to conducting tests for stationarity and cointegration, we employed Pesaran's (2004) CD test to assess cross-sectional dependency (CD) .This test computes the OLS residual mean from Equation (1) to determine the pairwise correlations. As the number of observations increases, the distribution of the residuals approaches a normal distribution. The highly significant and statistically significant CD statistics in Table 3 show cross-state dependency. Therefore, the unit root tests provided with the regular panel are not appropriate for this particular CD. The research used panel unit root tests like Breitung and IPS, which ignore cross-state dependency, unlike the CIPS test. Cross-state dependencies make Pesaran's CIPS test suitable for unit root testing. This test use the CCE approach to remove the common driver (CD) by enhancing the individual average distributed lag (ADF) regressions with CD averages. Table 4 displays the unit root tests results performed by Im *et al*. (2003) and Breitung (2001) for both levels and initial differences considering cross-sectional independence. SIC criteria is used to ascertain the lag order. All variables' CIPS levels and initial differences are shown in Tables 5 and 6. We looked at the trend and intercept independently. Lag orders $\rho = 0,1,2,3$ are taken into account in the CIPS unit root test. According to the CIPS test results, the variables are either integrated of order one (I (1)) in first-differences or stationary in first-differences. According to the Pesaran's CD test (refer to Table 3), the analysis suggests that the appropriate test to use is the CIPS unit root test.

Table 3. Results of CD test of the selected variables

Variables	CD test	Correlation	*p*-value
lpsdp	65.34	0.98	0.00
lhe	47.00	0.71	0.00
ur	42.44	0.64	0.00
lfpr	64.97	0.98	0.00
ldebt	66.03	0.99	0.00
popgr	35.51	0.54	0.00
fger	21.29	0.32	0.00

For this purpose, we have employed the cointegration tests proposed by Kao (1999), Pedroni (2001) and Westerlund (2007) to evaluate the interdependence of the variables over time. Table 7 shows the results of the panel cointegration tests. Using the statistics of Kao and Pedroni, We found that all variables are cointegrated. With cross-unit long-run interactions, panel cointegration tests can be significantly larger (Banerjee *et al*., 2004). Ignoring these linkages could lead to findings that support cointegration even if they might not be accurate. Consequently, it becomes sense to do the Westerlund test, which provides reliable cointegration findings while accounting for CD.

The results of the Westerlund cointegration test have validated the existence of cointegration among all selected variables in this study. After confirming cointegration, we calculate Equation (1)'s long-term coefficients. The study's objective is to ascertain how healthcare spending affects economic growth. Three distinct estimators – the MG, CCEMG and the CCEP estimates – are used in the empirical implementation in comparison to the benchmark fixed effect (FE) estimator (refer to Table 8).

In FE estimation, the maximum number of variables' coefficients is statistically significant. One reason is that the cross-sectional dependence of the data is not accounted for in the fixed effects estimation. The MG estimates exclude unobserved common factors; however, Pesaran's (2006) CCEMG and CCEP estimators integrate the cross-sectional averages of both independent and dependent variables as additional regressors to account for unobserved common factors with heterogeneous factor loadings. This offers enhanced flexibility as the impacts of unobserved common factors may vary across states, and their progression may be non-stationary or non-linear (Kapetanios *et al*., 2011).

According to our findings, even after controlling for other variables health spending generally has a statistically significant and favourable impact on economic growth. Both the estimates of CCEMG and CCEP confirm that health expenditure and labour force participation rate have favourable and statistically significant impact on the rate of economic growth. The health expenditure elasticity is highest (i.e. 0.05) when estimated using FE and MG, and lowest (i.e. 0.01) when estimated using CCEMG and CCEP. A 1% increase in public health expenditure results in a 0.05% point rise in economic growth. The coefficient estimate for lfpr is 0.01 across all models, indicating that a one percentage point increase in lfpr results in a 0.01% point increase in the economic growth rate.

Although the model finds that other variables such as the unemployment rate, public debt, population growth and female gross enrolment rate are statistically insignificant, the signs of their estimated coefficients are consistent with their theoretical predictions.

Across all estimators, the coefficients for female education are not significant but positive. It suggests that although the correlation between female education and economic growth may lack statistical significance, elevated levels of female education appear to exert a distinctly positive influence on economic growth. Therefore, the findings imply that investing human capital in healthcare and education is complementary. Furthermore, a higher female-to-male

Table 4. Results of first-generation panel unit root tests

Variables	Breitung (level) INT	INT and TR	Breitung (1st Diff.) INT	INT and TR	IPS (level) INT	INT and TR	IPS (1st Diff.) INT	INT and TR
lpsdp	14.46 (1.00)	2.11 (0.98)	−11.70*** (0.00)	−10.89*** (0.00)	12.20 (1.00)	−3.15*** (0.00)	−15.06*** (0.00)	−15.69*** (0.00)
lhe	2.97 (0.99)	−1.41* (0.08)	−15.75*** (0.00)	−12.38*** (0.00)	3.93 (1.00)	−4.02*** (0.00)	−15.17*** (0.00)	−15.38*** (0.00)
ur	0.33 (0.63)	3.54 (0.99)	−13.01*** (0.00)	−1.63** (0.05)	3.31 0.99	0.03 0.51	−10.66*** (0.00)	−10.82*** (0.00)
lfpr	3.84 (0.99)	6.39 (1.00)	−8.44*** (0.00)	−2.91*** (0.00)	−2.01** (0.02)	6.14 (1.00)	−4.49*** (0.00)	−5.63*** (0.00)
ldebt	17.54 (1.00)	4.13 (1.00)	−12.05*** (0.00)	−11.63*** (0.00)	−0.92 (0.18)	0.91 (0.81)	−11.70*** (0.00)	−12.64*** (0.00)
popgr	0.56 (0.71)	−2.93*** (0.00)	−17.10*** (0.00)	−16.73*** (0.00)	0.94 (0.83)	−1.43* (0.07)	−14.62*** (0.00)	−14.73*** (0.00)
fger	0.16 (0.56)	−1.89** (0.03)	−17.09*** (0.00)	−16.47*** (0.00)	−1.49* (0.07)	−3.63*** (0.00)	−15.02*** (0.00)	−15.19*** (0.00)

Note(s): Parenthesis is used to report *p*-values. 1%, 5% and 10% of rejections are denoted by the symbols ***, ** and * respectively

Table 5. CIPS-based panel unit root results

Level variables	Only constant Lags 0	1	2	3
lpsdp	−2.173** (0.049)	−1.556 (0.811)	−1.365 (0.952)	−1.321 (0.968)
lhe	−2.666*** (0.000)	−2.478*** (0.002)	−2.188** (0.043)	−2.436*** (0.003)
ur	−2.019 (0.153)	−1.427 (0.921)	−2.498*** (0.001)	−2.490*** (0.002)
lfpr	−1.751 (0.530)	−2.143* (0.062)	−2.432*** (0.003)	−2.602*** (0.000)
ldebt	−1.213 (0.989)	−1.414 (0.929)	−1.454 (0.903)	−1.517 (0.851)
popgr	−1.706 (0.604)	−1.728 (0.568)	−1.756 (0.523)	−1.791 (0.465)
fger	−2.184** (0.044)	−2.065 (0.112)	−1.662 (0.671)	−1.826 (0.409)
Variables in first difference				
lpsdp	−6.115*** (0.000)	−4.825*** (0.000)	−3.483*** (0.000)	−2.877*** (0.000)
lhe	−6.016*** (0.000)	−4.921*** (0.000)	−3.674*** (0.000)	−3.330*** (0.000)
ur	−5.334*** (0.000)	−2.464*** (0.002)	−2.130* (0.069)	−2.313** (0.013)
lfpr	−4.476*** (0.000)	−2.967*** (0.000)	−1.749 (0.534)	−1.827 (0.407)
ldebt	−4.912*** (0.000)	−3.682*** (0.000)	−2.788*** (0.000)	−2.533*** (0.001)
popgr	−6.012*** (0.000)	−4.075*** (0.000)	−3.178*** (0.000)	−2.616*** (0.000)
fger	−5.804*** (0.000)	−4.667*** (0.000)	−3.387*** (0.000)	−3.032*** (0.000)

Note(s): Parenthesis is used to report *p*-values. 1%, 5% and 10% of rejections are denoted by the symbols ***, ** and * respectively

Table 6. CIPS-based panel unit root tests statistics

Level variables	Constant and trend Lags 0	1	2	3
Lpsdp	−3.181*** (0.000)	−2.617 (0.111)	−2.512 (0.225)	−2.497 (0.245)
Lhe	−3.036*** (0.001)	−2.956*** (0.003)	−2.640* (0.094)	−2.899** (0.007)
Ur	−2.159 (0.787)	−1.295 (1.000)	−2.586 (0.140)	−2.723** (0.046)
Lfpr	−1.774 (0.994)	−1.818 (0.989)	−2.007 (0.928)	−2.486 (0.261)
Ldebt	−1.982 (0.943)	−2.144 (0.806)	−2.204 (0.726)	−2.437 (0.335)
Popgr	−1.681 (0.998)	−1.701 (0.998)	−1.725 (0.997)	−1.757 (0.995)
Fger	−2.390 (0.413)	−2.212 (0.714)	−1.824 (0.988)	−1.905 (0.972)
Variables in first difference				
Lpsdp	−6.324*** (0.000)	−4.873*** (0.000)	−3.555*** (0.000)	−3.014*** (0.002)
Lhe	−6.119*** (0.000)	−4.896*** (0.000)	−3.671*** (0.000)	−3.309*** (0.000)
Ur	−5.570*** (0.000)	−2.628 (0.103)	−2.248 (0.658)	−2.457 (0.304)
Lfpr	−4.678*** (0.000)	−3.177*** (0.000)	−1.975 (0.946)	−2.042 (0.905)
Ldebt	−5.089*** (0.000)	−3.791*** (0.000)	−2.910** (0.006)	−2.571 (0.154)
Popgr	−6.012*** (0.000)	−4.113*** (0.000)	−3.245*** (0.000)	−2.715** (0.050)
Fger	−5.945*** (0.000)	−4.786*** (0.000)	−3.472*** (0.000)	−3.186*** (0.000)

Note(s): Parenthesis is used to report *p*-values. 1%, 5% and 10% of rejections are denoted by the symbols ***, ** and * respectively

enrolment ratio in educational institutions correlates with increased workforce participation among women and greater financial resources available for healthcare expenditures.

10. Conclusion

There is a well-established correlation between economic expansion and healthcare expenditure, with higher incomes typically resulting in improved health outcomes and

Table 7. Panel cointegration tests

Cointegration tests	Statistic	*p*-value
Kao test		
Modified DF t	−5.66***	0.00
DF t	−4.52***	0.00
Augmented DF t	−2.98***	0.00
Unadjusted modified DF t	−7.63***	0.00
Unadjusted DF t	−5.08***	0.00
Pedroni test		
MPP t	2.08**	0.02
PP t	−2.25**	0.01
ADF t	−2.22**	0.01
Westerlund test		
Variance ratio (H_a^p : α_i = α < 0)	−1.950**	0.026
Variance ratio $(H_a^p : \alpha_i = \alpha < 0)$ *for* $\forall_i$	−1.967**	0.025

Note(s): 1%, 5% and 10% of rejections are denoted by the symbols ***, ** and * respectively

Table 8. Estimation results

Dependent variable	Lpsdp			
Variables	*FE*	*MG*	*CCEMG*	*CCEP*
Lhe	0.05*** (0.00)	0.05*** (0.00)	0.01** (0.02)	0.01** (0.05)
Ur	−0.02*** (0.00)	−0.05** (0.01)	−0.0004 (0.98)	−0.01 (0.89)
Lfpr	0.01*** (0.00)	0.01** (0.05)	0.01** (0.04)	0.01** (0.00)
Ldebt	0.33*** (0.00)	0.28*** (0.00)	0.02 (0.74)	0.01 (0.49)
Popgr	0.01 (0.61)	0.08 (0.16)	0.12 (0.12)	2.08 (0.29)
Fger	0.005*** (0.00)	0.0003 (0.88)	0.0002 (0.73)	0.0001 (0.87)
No. of observations	630	630	630	630

Note(s): Parenthesis is used to report *p*-values. 1%, 5% and 10% of rejections are denoted by the symbols ***, ** and * respectively

healthcare. The correlation between improved health and economic development has become more significant after the influential research on Muskin's health-led growth theory. Furthermore, the human capital theory serves as the inherent mechanism that links economic success with health conditions. An individual's health status constitutes a component of their human capital. Substandard health diminishes both the volume and calibre of work executed. Moreover, it results in insufficient human capital accumulation. Improvements in health influence both the magnitude and growth rate of per capita income.

This study examines the long-term relationship between public health expenditure and economic activity in 15 significant Indian states from 1981 to 2022. This paper also examines the impact of public health expenditure on the economic growth rate after accounting for other variables, including the unemployment rate, population growth rate, outstanding debt liabilities, female labour force participation rate and female total enrolment rate. Public health spending and economic growth are examined for non-stationarity and cointegration. The empirical results from all panel cointegration tests, including the Kao, Pedroni and Westerlund tests, demonstrate a long-term association among healthcare spending and economic expansion in the presence of other control variables, after controlling for the unobserved heterogeneity and the CD. The primary factors driving India's economic growth rate are public health expenditure and the labour force participation rate, as confirmed by the evidence from

CCEMG and CCEP. The economic growth is statistically significant and favoured by both public health expenditure and labour force participation.

The findings highlight the importance of financing public health expenditures, supported by statistically significant and positive effects on economic growth. Budgeting for the healthcare sector in a way that enhances infrastructure, access to services and general population health should be a top priority for policymakers. Research findings demonstrate the substantial influence of labour force participation on the economic growth rate. Policies aimed at fostering economic growth have the potential to increase the labour force participation rate. This may involve enhancing childcare facilities, expanding access to education and skill development programs and promoting gender equality in the workplace. Measures should be implemented to promote gender equality in the workplace, enhance access to education and skill development programs and improve childcare facilities. Economic growth is influenced by the cumulative effects of these factors over time, so consistent and sustained efforts in these areas are essential for achieving desired growth outcomes. Given that the study concentrates on 15 major Indian states, regional differences in healthcare availability and economic development warrant policymakers' attention. In order to guarantee more equitable growth across the nation, tailored actions could be required to meet particular possibilities and difficulties in certain regions.

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Notes

1. Health is a capital productive asset and human growth is an aim in itself, therefore technological advancements and improvements in medical science have improved the economic welfare of populations worldwide and are a primary factor driving up health spending. Here is dispute on the connection between public health spending and economic expansion. In a young developing country like India, social welfare and equitable considerations make the public sector's role in providing and financing health services more crucial (Balarajan, 2011). Public funding must be provided with limited public resources, which makes efficient spending and priority setting even more crucial.
2. A detailed analysis is given in the next section.
3. India, which has a disproportionately high economic performance and supports a staggering 16.7% of the global population despite making up only 2.4% of the planet's land. It has been observed that policy regimes impact the development of Indian states. States in India have seen a tendency for their per capita state domestic product (SDP) to diverge rather than converge. The interstate inequalities of income among Indian states has been increasing steadily. Growth in the per capita SDP is strongly correlated with baseline income levels. States that have superior human resources and sound infrastructure have drawn greater investment.
4. There has been a consistent rise in the disparity in income amongst the Indian states. The beginning income levels and the rise of per capita SDP are positively correlated. Higher investment has been attracted to states with superior human resources and infrastructure. The growing differences in geography between the Indian states and the distinct division between the states he refers to as the forward and backward states.
5. These estimators incorporate unobserved shared elements with diverse factor loadings by including the cross-sectional means of both the independent and dependent variables as supplementary explanatory factors.

6. The article by Breitung and Pesaran (2008) contains a comprehensive examination of these panel unit root test.
7. The Breitung and IPS tests are among the first-generation unit root tests, while the CIPS test is included in the second-generation unit root tests. Although the Breitung and IPS tests continue to be the two most frequently employed unit root tests in numerous empirical analyses, plenty of research studies have shown that the empirical magnitude of a panel unit root can substantially deviate from the nominal size if CD is disregarded (Banerjee and Carrion-i-Silvestre, 2015).

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