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Impact of GDP and tax revenue on health care financing: An empirical investigation from Indian states

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Abstract. *This paper examines the long run effects of GDP and tax revenue on public health expenditure for sixteen major states of India over the period 1980-2014. We apply panel long run cointegrating estimator (FMOLS and DOLS) and panel VECM techniques for the empirical analysis. This study is more relevant for financial progress towards universal health coverage of India because Indian states are heterogeneous in terms of public health expenditure, associated with low tax revenue and low level of GDP growth. The empirical result shows that there is a positive and significant impact of per capita GDP and per capita tax revenue on growth of public health expenditure while the elasticity of public health expenditure is less than one. Further, there is a long run causality from the growth of per capita GDP and per capita tax revenue to the growth of per capita public health expenditure. These results have policy implications for universal health coverage by improving alternative tax revenue in Indian states.*

Keywords: public health expenditure; Indian states; GDP; tax revenue.

JEL Classification: H51, H2, H75.

1. Introduction

The health care financing is a key building block of the health system[1] functions framework and plays an influential role in attainment of universal health coverage goals (Kutzin, 2013). Mathauer and Guy (2011) have systematically designed health care financing performance indicators for low income countries in order to achieve universal health coverage[2] (UHC). Some of the relevant indicators are per capita government health expenditure, government health expenditure as percentage of gross domestic product (GDP), government expenditure as percentage of gross domestic product (fiscal space) and government health expenditure as percentage of total government expenditure (fiscal space for health) etc. These indicators are measured by the country's income level and financial affordability of the government. Reeves et al. (2015) explains the health financing mechanism for the low and middle income countries to achieve the breadth-depth-height of health system coverage. It has taken government health expenditure as one of the indicators of UHC denoted as dependent variables, tax revenue and GDP taken as independent variables to measure the progress towards UHC. The challenge for many low and middle income countries is how to increase public health care expenditure in order to achieve UHC because these countries heavily rely on out-of-pocket health care expenditure (Mathauer and Guy, 2011).

India is not an exception in health system challenge and also suffers huge shortage of finance in public health care. As a consequence of this, the public health care delivery system suffers from inadequate health care services, severe staff shortage, lower quality of infrastructure and catastrophic out-of-pocket expenditure (Kurian, 2015). Choudhury (2014) says that the level of public health expenditure as percentage of gross state domestic product (GSDP) is around one percent in most of the poor performing states in India due to low budgetary space[3]. Duran et al. (2014) explains that fiscal space for health shifted only from 4.6 percent to 4.8 percent during the period 2007-08 to 2012-13; it suggests that India requires a health system for financing in UHC and requires more emphasis primarily on general tax revenues by generating more income.

The main motivation of this study starts from the state's role in financing health care for the implementation of Universal Health Coverage (UHC) in India. Because, health is a state subject in India and financing for public health care is solely depends on the budgetary space of the state government. The budgetary space for spending is driven by the income and tax revenue of the government and it is also one of the objective for achieving universal health coverage. Beside the above supply side factors, other demand side factor such as per capita income, demographic structure, morbidity pattern etc. also affects the nature and type of heath care expenditure. The important point here is to see the position of the state government in financing public health care from its own budgetary space as income level and tax revenue to mitigate health demands of the people without help of the central government assistance. So, this study has taken into consideration income level and own tax revenue of the state government to measure the level of health care expenditure.

1.1. Past literature

There is a growing literature on the nexus between public health expenditures and GDP, which can be broadly grouped into three different lines of inquiry. The first strand of literature examines the elasticity of public health expenditure with respect to GDP in the short run as well as in the long run. The literature deals with short run estimator of health expenditure studies such as Sen (2005); Wang (2009); Baltagi and Francesco (2010); Cantarero and Lago Penas (2010); Farag et al. (2012); Fan and Savedoff (2014); Reeves et al. (2015); and the literature deals with the long run estimators of health expenditure such as Narayan et al. (2010); Khan et al. (2015); Wang (2011); Tamakoshi and Shigeyuki (2014). These studies find per capita GDP to be the most important determinant of per capita public health expenditure. The economic interpretation of these findings is that, the elasticity of public health expenditure with respect to GDP is equal to or greater than one, leading to the conclusion that health care is a luxury rather than a necessity. When elasticity is less than unity, health care is closer to being a necessity than a luxury. Whether health care is a luxury or a necessity, it has an implication on the link between public health expenditure and economic well-being. The second strand of literature (Gerdtham and Mickael, 2000; Herwartz and Bernd, 2003; MacDonald and Sandra, 2002; McCoskey and Thomas, 1998; Wang, 2011; Dreger and Hans, 2005; Tamakoshi and Shigeyuki, 2015) deals with investigating evidence for a long run (cointegrating) relationship between public heath expenditure and GDP. The third strand of literature (Devlin and Paul, 2001; Erdil and Yetkiner, 2009; Hartwig, 2010; Wang, 2011; Amiri and Venetelou, 2012) examines the causality between public health expenditure and GDP in the short-run as well as long-run. There are two types of causality between public health expenditure and GDP; it could be either unidirectional (that is, public health expenditure as a function of GDP or GDP as function of public health expenditure) or bidirectional (that is, both public health expenditure and GDP causing each other). The direction of causality is important, as the health policy implications are vastly different for each possible direction. The unidirectional causality from public health expenditure to GDP (reverse causality) indicates that the public health expenditure has both direct and indirect effects on economic growth (Hartwig, 2010). The theoretical argument is that public health expenditure can be considered as an investment in human capital and leads to healthier workforce. Hence as a factor of production, an increase in the efficiency helps augmenting the economic growth (Devlin and Paul, 2001). On the other hand, the unidirectional causality from GDP to public health expenditure is a general phenomenon in almost all countries. But the implication of increasing public health expenditure is that, it reflects the intention of economic development, and exhibits the improvement in the quality of life of people (Wang, 2011). The presence of bidirectional causality between public health expenditure and GDP implies that public health expenditure and economic growth are jointly affected by shocks and conservative health policies may have an adverse effect on income and vice versa (Amiri and Venetelou, 2012).

Regarding studies on India, there is limited work on the nexus between public health expenditure and GDP. Bhat and Nishant (2006); Rahman (2008); Hooda (2015), examined the relationship between GDP and public health expenditure among the Indian states, found that per capita GSDP affects positively to the growth public health expenditure. These studies use random effect regression model to estimate the short run impact of income on the growth of health care expenditure. The result shows that the value of income elasticity of public health expenditure varies between 0.47-0.68, which implies that health care is not a luxury good among the Indian states. These studies have overlooked the long run relationships between GDP and public health expenditure in the state level. The literature relating to the long run impact assessment of per capita GDP on per capita public health expenditure are scarce in the state level of India, except the recent study of Behera and Dash (2016). They argued that public health expenditure and GDP are cointegrated in the long run and found positive relationship between them. But it ignores the role of state's per capita tax revenue in order to finance health care because the literature argues that tax revenue is most contributing factor for the growth of public health expenditure (Reeves et al., 2015; Cantarero and Santiago, 2010; Fan and Savedoff, 2014). The studies like Reeves et al. (2015) and Cantarero and Santiago (2010) have taken tax revenue as the one of the explanatory variables for explain the growth of public health expenditure. These studies found that tax revenue affects positively to the growth of public health expenditure in the short run, while the long run impact assessment of tax revenue on growth of public health expenditure is very rare in literature. The studies such as Reeves et al. (2015) and Fan and Savedoff (2014) have argued that mobilization of funds through domestic tax revenue is the sustainable sources of financing for health care and implement health policies.

The contribution of this paper may be described as follows: First, we examine the long run effects of per capita GSDP and per capita tax revenue on per capita public health expenditure using long run estimator techniques such as FMOLS for heterogeneous cointegrated panel proposed by Pedroni (2000) and DOLS techniques proposed by Kao and Chiang (2000). Second, we examine the causal relationships between per capita public health expenditure, per capita GSDP and per capita tax revenue using the panel vector error correction model (VECM) econometric model that combines short-run and long-run dynamics. Our result shows that there is a positive and significant impact of per capita GDP and per capita tax revenue on growth of per capita public health expenditure while the elasticity of per capita public health expenditure is less than one. Further, there is a long run causality from the growth of per capita GDP and per capita tax revenue to the growth of per capita public health expenditure. These research findings would serve as effective policy instruments to understand the financial progress towards universal health coverage of Indian states.

Based on the background information mentioned above, the objective of this paper is to examine the long run impact of GDP and tax revenue on public health expenditure for sixteen major states of India over the period 1980-2014. The remainder of this paper is organised as follows. Section 2 presents a brief overview of public health expenditure scenario of the states of India. Section 3 describes the data and methodology. Section 4 presents the results from empirical analysis and Section 5 is the conclusion.

2. A brief overview of public health care expenditure trends of Indian states

Our objective in this section is twofold. The first objective is to provide a comparison of public health expenditure trends as percent of GSDP vis-à-vis trends of tax revenue as percent of GSDP of sixteen Indian states over the three time periods i.e. 1980-1989;

1990-1999; and 2000-2014. The second objective is to show how heterogeneous the sixteen states are with respect to per capita public health expenditure vis-à-vis per capita GSDP and per capita tax revenue during the period 2000-2014.

Table 1. *Trends of public health expenditure and tax revenue (Average)*

	Public health expenditure as percent of GSDP			State's own tax revenue as percent of GSDP		
Major states of India	1980-1989	1990-1999	2000-2014	1980-1989	1990-1999	2000-2014
Andhra Pradesh (AP)	1.94	1.34	1.23	11.96	10.18	12.75
Assam (ASM)	1.16	0.94	1.04	2.75	3.20	5.08
Bihar (BIH)	1.52	1.60	1.07	5.12	5.93	4.79
Gujarat (GUJ)	0.94	0.69	0.55	6.61	7.03	6.77
Haryana (HAR)	0.96	0.55	0.46	6.67	6.56	7.18
Himachal Pradesh (HP)	2.77	1.86	1.47	3.86	4.32	5.52
Karnataka (KAR)	1.03	0.84	0.73	7.17	7.76	9.32
Kerala (KER)	1.32	0.92	0.83	6.42	7.13	7.82
Madhya Pradesh (MP)	1.47	1.01	0.84	6.40	6.71	7.27
Maharashtra (MAH)	1.05	0.57	0.50	7.02	6.48	7.14
Odisha (ODI)	1.15	0.90	0.76	3.28	3.82	5.56
Punjab (PUN)	0.93	0.74	0.65	6.77	6.09	7.22
Rajasthan (RAJ)	0.10	1.00	0.92	4.65	4.88	6.40
Tamil Nadu (TN)	1.21	0.85	0.67	7.23	7.56	8.53
Uttar Pradesh (UP)	1.09	0.93	1.02	4.33	4.75	6.59
West Bengal (WB)	1.09	0.90	0.75	4.86	4.88	4.57
All States	1.11	0.80	0.75	5.33	5.48	6.63

Source: State finance of budget and handbook of statistics on the Indian Economy, RBI.

We begin with Table 1, where we report the trends of public health expenditure over the period 1980-2014. Two messages are worth noting here. First, for India as a whole (All States), public health expenditure as percent of GSDP reduced from 1.11 percent over the period 1980-1989 to 0.75 percent of GSDP in the period 2000-2014. The second message is that, for the majority of the states, public health expenditure as percent of GSDP has decreased in the period 2000-2014 compared to the 1980-1989 period. Similarly, from the trend analysis of tax revenue of Indian states over the period 1980-2014, we found two observations. First, the growth of tax revenue as percent of GSDP of India (All States) has increased from 5.33 percent in the period 1980-1989 to 6.63 percent in the period 2000-2014. Second, majority of Indian states have increased revenue productivity (tax revenue as percent of GSDP) over the period 2000-2014 than the period 1980-1989.

From our simple trend analysis of the data, it is clear that states are heterogeneous in terms of average public health expenditure. To further measure the degree of heterogeneity, Figure 1 is shown the scatter plots of the growth of per capita public health expenditure with respect to changes in per capita GSDP over the period 2000-2014. Figure 1 shows that the states such as Karnataka, Punjab, Tamil Nadu, Gujarat, Maharashtra and Haryana are having higher per capita income and showing lower level of per capita public health expenditure. Similarly, the states such as Uttar Pradesh, Madhya Pradesh, Odisha, West Bengal and Bihar are having lower per capita income but having lower level of per capita public health expenditure. While the states namely Andhra

Pradesh, Kerala and Himachal Pradesh are exhibits higher level of per capita public health expenditure with respect to higher level of per capita income.

Figure 1. *GSDP and public health expenditure trends of Indian states (Avg. 2000-2014)*

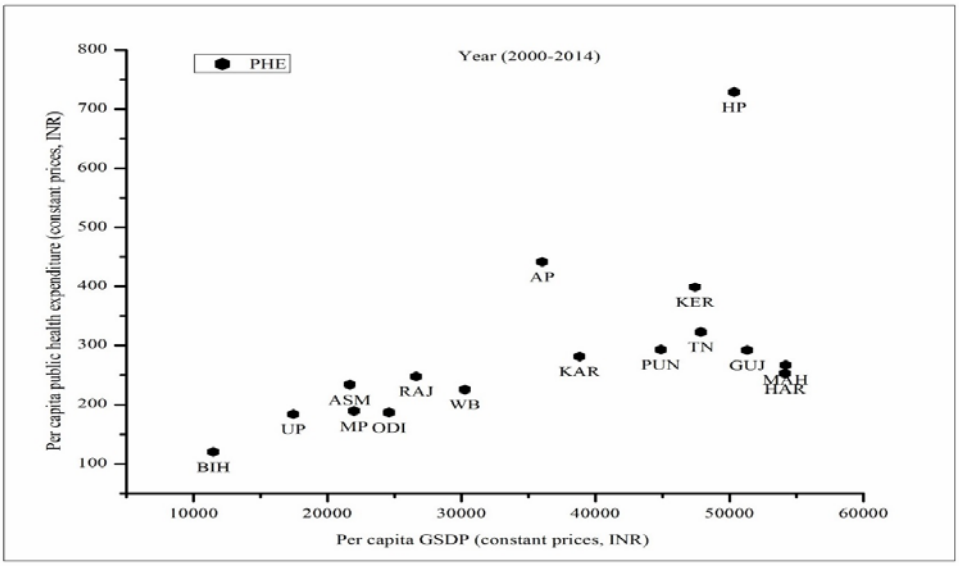
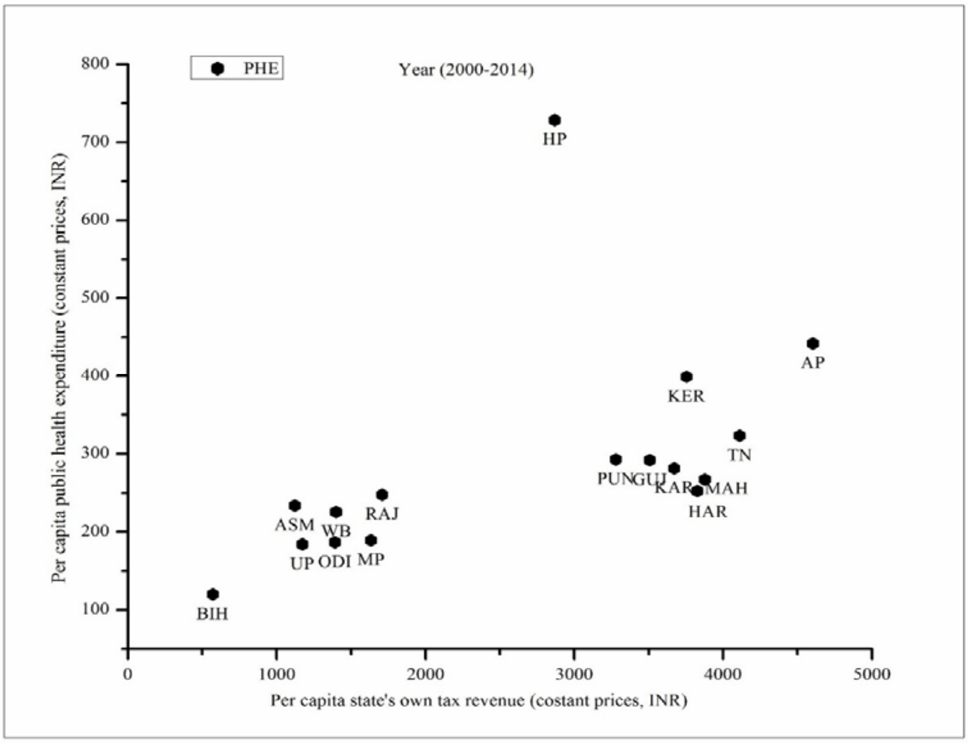


Figure 2. *Tax revenue and public health expenditure trends of Indian states (Avg. 2000-2014)*



In Figure 2, we presents the scatter plot analysis of per capita public health expenditure with respect to per capita tax revenue of Indian states over the period 2000-2014. We notice that the state's namely Punjab, Gujarat, Karnataka, Maharashtra, Haryana and Tamil Nadu are having higher per capita tax revenue associated with lower level of per capita public health expenditure. Similarly, the state's namely Uttar Pradesh, Odisha, Madhya Pradesh and Bihar are having lower per capita tax revenue associated with lower level of per capita public health expenditure. While the states namely Andhra Pradesh, Kerala and Himachal Pradesh are having higher level of per capita public health expenditure associated with higher level of per capita tax revenue.

Overall trends analysis concludes that there is a huge variation in the growth of per capita public health expenditure among the states of India. Further, lower income states are not able to mobilise more resources towards public health expenditure due to lower level of revenue growth. On the contrary, higher income states are also fails to mobilise more resources towards public health expenditure despite higher level of revenue growth.

3. Data and methodology

3.1. Data description

The selection of the period from 1980-81 to 2014-15 is based on the availability of the required data on public health expenditure and relevance of the time period. This period is of great significance as it captures the period of two and a half decade of economic reform/liberalization and also includes the impact of national health policies. It allows us to study the changing pattern and trend of health expenditure in various states of India. We have considered for our analysis, the sixteen major states, covering 93 percent of the population and accounting for 95 percent of the total income of the country. The expenditure and population data are drawn from state finance budget report and handbook of statistics on the Indian economy published by the Reserve Bank of India. The study uses one dependent variables namely, real per capita public health care expenditure (PCPHE) and two independent variables namely, real per capita gross state domestic product (PCGSDP) and real per capita tax revenue (PCTREV). Since price deflators series are not available at the state level, the national level Price Index for all commodities at constant (2004-2005=100) prices has been used to convert the nominal values into real (constant) values. Finally, we convert all the variables used in the empirical model into natural logarithm.

Table 2. *Results of descriptive statistics*

Variables	Description	Mean	Std. Dev.	Maximum	Minimum	Observations
PCPHE	Per Capita Public Health Expenditure	229.07	141.81	1158.02	70.98	560
PCGSDP	Per Capita Gross State Domestic Product	25172.32	15685.35	81981.42	5930.92	560
PCTREV	Per capita State's own tax revenue	1732.76	1373.05	6743.64	271.84	560

Note: All variables are in real constant 2004-05 prices (INR: Indian Rupees).

The Table 2 presents descriptive statistics of the variables for the states in our empirical analysis during the study period. The result shows that variable PCPHE has a minimum value of INR 70.98 and a maximum value an INR 1158.02 with a mean value of Rupees 229.07. So, there is high degree variation in per capita public health expenditure among the Indian states. Also, it shows that all the variables PCPHE, PCGSDP, PCTREV reveal a considerable degree of standard deviation with huge difference in minimum and maximum values.

3.2. Empirical methods

First, we examine the long run effects of per capita GSDP and per capita tax revenue on per capita public health expenditure using long run estimator techniques such as FMOLS for heterogeneous cointegrated panel proposed by Pedroni (2000) and DOLS techniques proposed by Kao and Chiang (2000). The simple panel OLS regression equation as follows:

$$Y_{it} = \alpha_i + \beta_i X_{it} + \mu_{it} \tag{1}$$

In Eq. (1), Y_{it} and X_{it} are cointegrated with slopes β_i which may or may not be homogeneous across i. In this case, the null hypothesis is $H_0 : \beta_i = 1$ for all i. Let $\varepsilon it == \left(\hat{\mu}_{it}, \Delta X_{it}\right)'$ be a stationary vector consisting of the estimated residuals from the cointegrating regression and difference in X_{it}. Let $\Omega_i \equiv \lim_{T\to\infty} E\left[T^{-1}\left(\Sigma_{t=1}^{T}\varepsilon_{it}\right)\left(\Sigma_{t=1}^{T}\varepsilon'_{it}\right)\right]$ be the long-run covariance matrix and it can be decomposed as $\Omega i = \Omega_i^0 + \Gamma_i + \Gamma'_i$, where Ω_i^0 is the contemporaneous covariance and Γ_i is a weighted sum of autocovariances. Using this notation, the panel FMOLS estimator is given as:

$$\hat{\beta}^*_{GFM} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \left(X_{it} - \bar{X}_i \right)^2 \right)^{-1} \times \left(\sum_{t=1}^{T} \left(X_{it} - \bar{X}_i \right) Y_{it}^* - T\hat{\tau}_i \right) \tag{2}$$

Where,

$$Y_{it}^* = (Y_{it} - \bar{Y}_i) - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} \Delta X_{it},$$

$$\hat{\tau}_i = \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^o - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} (\hat{\Gamma} 22i + \hat{\Omega}_{22i}^o).$$

In a similar fashion, the panel DOLS regression equation becomes:

$$Y_{it} = \alpha_{it} + \beta_i X_{it} + \sum_{k=-K_i}^{K_i} \gamma_{ik} \Delta X_{it-k} + \mu_{it} \tag{3}$$

From Eq. (3), we construct the panel DOLS estimator, mentioned as below:

$$\hat{\beta}^*_{GD} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} z_{it} z'_{it} \right)^{-1} \times \left(\sum_{t=1}^{T} z_{it} \tilde{Y}_{it} \right) \tag{4}$$

Where, $\hat{\beta}_{GD}$ is group mean distributer of panel dynamic OLS,

$Z_{it} = \left(X_{it} - \bar{X}_i, \Delta X_{it-K}, ..., \Delta X_{it+K}\right), \tilde{Y}_{it} = Y_{it} - \bar{Y}_i$ and Z_{it} is the $2(K+1)^*1$ vector of regressors.

Second, we examine the causal relationships between per capita public health expenditure, per capita GSDP and per capita tax revenue using the panel vector error correction model (VECM) econometric model that combines short run and long run dynamics. VECM can be developed as follows:

Model – 1 (5)

$$\Delta \ln PCPHE_{it} = \beta_{1g} + \sum_p \beta_{11ip} \Delta \ln PCPHE_{it-p} + \sum_p \beta_{12ip} \Delta \ln PCGSDP_{it-p} + \psi_{1i} ECT_{t-1}$$

$$\Delta \ln PCGSDP_{it} = \beta_{2g} + \sum_p \beta_{21ip} \Delta \ln PCGSDP_{it-p} + \sum_p \beta_{22ip} \Delta \ln PCPHE_{it-p} + \psi_{2i} ECT_{t-1}$$

Model – 2 (6)

$$\Delta PCPHE_{it} = \beta_{1g} + \sum_p \beta_{11ip} \Delta PCPHE_{it-p} + \sum_p \beta_{12ip} \Delta \ln PCTREV_{it-p} + \psi_{1i} ECT_{t-1}$$

$$\Delta \ln PCTREV_{it} = \beta_{2g} + \sum_p \beta_{21ip} \Delta \ln PCTREV_{it-p} + \sum_p \beta_{22ip} \Delta PCPHE_{it-p} + \psi_{2i} ECT_{t-1}$$

Where

Δ -denotes the first difference of the variables, p denotes the lag length and ECT_{t-1} denotes the lagged error correction term, found from the long run cointegrating equations. The long run causality can be obtained in the VECM model by looking at the significance of the estimated coefficient on lagged error correction term. The joint χ^2 (Chi-square) statistics of Wald test is used to investigate the direction of short-run causality between the variables. If the p parameter of β_{12ip} are jointly significant then $PCGSDP$ Granger cause $PCPHE$ in Model 1 and $PCTREV$ Granger cause $PCPHE$ in Model 2. Similarly, if the p parameter of β_{22ip} are jointly significant then $PCPHE$ cause $PCGSDP$ in Model 1 while $PCPHE$ cause $PCTREV$ in Model 2.

4. Empirical procedure and results

The empirical analyses of panel data in this study comprise the following four steps. First, we test for a panel unit root test to ascertain the order of integration of the variables. Second, we test for cointegration among panel data employing the panel cointegration test developed by Pedroni (1999, 2004) and Kao (1999) and a combined Johansen Fisher-type test (Maddala and Wu, 1999). Third, the long run equilibrium relationship is estimated using fully modified ordinary least square (FMOLS) and dynamic ordinary least squares (DOLS) techniques for heterogeneous cointegrated panels (Pedroni, 2000). Fourth, once the panel cointegration is established, we apply a panel-type VECM in order to test the causality between PCPHE, PCGSDP and PCTREV as well as the impact direction.

4.1. The Panel unit root test

To avoid any spurious and harmful interpretation of the findings, first we have to test the stationarity property of the variables in the data series. In this paper, we applied Levin et al. (2002), Breitung (2000), Im et al. (2003) and Maddala and Wu (1999) unit root test. Results from panel unit root tests are reported in Table 3. The results indicate that the null hypothesis of the existence of unit root could not be rejected for all of the variables at the selected level. However, the unit root null hypothesis for all of the variables at the first difference could almost be completely rejected at the 1 percent level.

Table 3. *Results of panel unit root tests*

Statistical Tests	LLC	Breitung	IPS	ADF - Fisher	PP - Fisher
Level					
PCPHE	2.194	5.802	4.270	10.655	6.226
PCGSDP	-0.082	5.273	4.163	15.661	22.458
PCTREV	2.612	3.806	4.061	11.434	12.627
First Difference					
PCPHE	-19.999*	-6.804*	-18.092*	300.784*	717.780*
PCGSDP	-22.587*	-5.421*	-23.250*	516.480*	853.691*
PCTREV	-14.959*	-6.835*	-16.860*	270.090*	544.313*

Notes: 1) LLC and IPS represent the panel unit root tests of Levin et al. (2002) and Im et al. (2003), respectively; Fisher-ADF and Fisher-PP represent the Maddala and Wu (1999) Fisher-ADF and Fisher-PP panel unit root tests, respectively. 2) The Schwarz information criterion (SIC) is used to select the lag length; the bandwidth is selected using the Newey–West method. Bartlett is used as the spectral estimation method. 3) All variables are formed in natural logarithm (ln) and estimation are made with individual intercept and linear trend. 4) * Statistical significant at 1 percent level.

4.2. The panel cointegration tests

As the results of the panel unit root tests indicate that the variables contain a panel unit root, we can proceed to examine whether there is a long run relationship among the variables using three types of cointegration tests: Pedroni (1999, 2004), Kao (1999), and Fisher-type testing using Johansen methodology (Maddala and Wu, 1999). The Pedroni and Kao tests are based on the Engle and Granger (1987) two step (residual-based) cointegration test. Pedroni (1999, 2004) proposes seven test statistics for cointegration that permit for heterogeneous intercept and linear trend coefficients across cross sections. The Kao (1999) test follows the same basic approach as the Pedroni test but lays down cross section specific intercepts and homogenous coefficients in the first stage regressors. Maddala and Wu (1999) use Fisher (1932) cointegration approach by combining tests from individual cross sections to obtain a test statistics for the entire panel.

We conducted panel cointegration test between per capita public health expenditure, per capita GSDP and per capita tax revenue indicators separately such as Model 1 (lnPCPHE and lnPCGSDP) and Model 2 (lnPCPHE and lnPCTREV). The Table 4 presents the results from the panel cointegration tests. The result has shown in ten test statistics such as panel v-statistics, panel rho-statistics, panel pp-statistics, panel-ADF statistics, group rho-statistics, group pp-statistics, group ADF-statistics, Kao statistics, max-eigenvalue statistics and trace statistics. The Model 1 explains that real per capita public health expenditure is a function of real per capita GSDP. The result shows that the null of no panel cointegration is rejected in all test statistics in Model 1. It implies that there exists a long run relationship between real per capita public health expenditure and real per capita GSDP in India at the aggregate level (national). The Model 2 explains that real per capita public health expenditure is a function of real per capita tax revenue. The result shows that the null of no panel cointegration is rejected in all test statistics in Model 2. It implies that there exists a long run relationship between real per capita public health expenditure and real per capita tax revenue in India at the aggregate level (national).

There are at least two possible reasons that may help support the strong association. First, the share of public health expenditure as a ratio of GDP has increased during the period 2000-2014. This might be happened due to increase the budgetary space of the state governments of India in order to mobilise more finance for health sector because state's own tax revenue capacity as a ratio state's GDP shown increment during the period 2000-2014 (Table 1). Second, growth of per capita income and per capita tax revenue have increased dramatically during the period (Figure 1 and Figure 2). So, it is evident that real per capita public health expenditure and real per capita GSDP are moving together in the long run.

Table 4. *Result of panel co-integration test*

Test statistics			In(PCPHE) and In(PCGSDP)	In(PCPHE) and In(PCTREV)
Padroni test				
panel v-statistics			2.964*	3.595*
panel rho-statistics			-4.641*	-3.034*
panel pp-statistics			-4.531*	-3.578*
panel ADF-statistics			-4.298*	-3.834*
group rho-statistics			-2.854*	-0.302
group pp-statistics			-4.357*	-3.471*
group ADF-statistics			-3.618*	-3.882*
Kao test			-3.661*	-3.092*
Johansen Fisher test	Hypothesized no. of CE(s)	None	78.48*	76.06*
Test trace statistics		At most 1	39.50	53.19**
Johansen Fisher test	Hypothesized no. of CE(s)	None	76.78*	66.65*
Test max-eigenvalue statistics		At most 1	39.50	53.19**

Notes: : 1) The Pedroni (1999) statistics are asymptotically distributed as normal. 2) In Johansen Fisher Panel Cointegration test, the hypothesized no. of cointegrating equations represented in trace and max-eigenvalue test statistics. 3) * Statistical significant at 1 percent level, ** Statistical significant at 5 percent level.

4.3. Long run effects of GDP and tax revenue on public health expenditure

Based on the evidence of cointegration, we estimate long run effects of per capita public health expenditure with respect to per capita GSDP and per capita tax revenue by using the panel FMOLS and DOLS estimators. The results of both FMOLS and DOLS estimators shows that per capita GSDP and per capita tax revenue are positively affects to the growth of per capita public health expenditure. The long run coefficient of PCGSDP suggests that at 1 percent increase in per capita income translates to 0.42 percent increment in per capita public health expenditure. Similarly, the long run coefficient of PCTREV suggests that at 1 percent increase in per capita tax revenue translates to 0.14-0.15 percent increment in per capita public health expenditure (Table 5: columns 3 and 6). After controlling tax revenue in both regression models, we found that the elasticity of PCPHE with respect to PCGSDP is 0.53 percent. It implies that the elasticity of income with respect to health expenditure is less than one and indicates that public health expenditure is not a luxury good in India. The similar finding are those of Behera and Dash (2016); Narayan et al. (2010); Khan et al. (2015); and Wang (2011) etc., which shows per capita income is the main determinant of the growth of per capita public health expenditure in long run and regression coefficient is less than one. The studies such as Reeves et al. (2016); Cantarero and Santiago (2010); and Fan and Savedoff (2014) have found tax revenue as one of determinants to the growth of public health expenditure but these studies have not estimated the long run effects of tax revenue on the growth of public health expenditure. After controlling PCGSDP in both regression models, we found that tax revenue is positively affects to the growth per capita public health expenditure in the long run. It implies that at 1 percent increase in tax revenue translates to 0.72 percent of increment in per capita public health expenditure. So, mobilization of tax revenue through economic growth is the important strategy in order to financing health care in India.

Table 5. *Result of the long run estimator of public health expenditure; Dep: ln (PCPHE)*

Variables	Fully modified ordinary least square (FMOLS)			Dynamic ordinary least square (DOLS)		
	1	2	3	4	5	6
ln(PCGSDP)	0.532^{*} (0.002)		0.426^{*} (0.045)	0.530^{*} (0.003)		0.423^{*} (0.043)
ln(PCTREV)		0.735^{*} (0.004)	0.148^{**} (0.063)		0.739^{*} (0.005)	0.152^{**} (0.062)
R-squared	0.528	0.279	0.538	0.781	0.624	0.819

Notes: 1) Figures in parenthesis are standard error values. 2) ln: natural logarithms. 3) * Statistical significant at 1 percent level, ** Statistical significant at 5 percent level.

4.4. Panel VECM Granger causality results

After conformation of the cointegration relationships between public health expenditure and GSDP (Model 1); and public health expenditure and tax revenue (Model 2), the Table 6 reports the results of Vector Error Correction Model (VECM) panel Granger causality of two models. We use the AIC value to determine the lagged period ρ that is most suitable for the model.

As shown in Table 6, there is an evidence of unidirectional Granger causality running from per capita GSDP to per capita PHE in Model 1. The long result has shown in long run error correction term (ECM_{it-1}) which is negative and significant. In other words, there has no Granger causality running from per capita PHE to per capita GSDP in long run. Our finding are line with the earlier studies like Pradhan and Bagchi (2012); Wang (2011); Khan et al. (2015); Amiri and Ventelou (2012); and Erdil and Yetkiner (2009) found long-run causality from economic growth to public health expenditure growth. Further, there is an existence of bidirectional Granger causality between per capita GSDP and per capita PHE in the short run. Our findings are thus in line with that of Pradhan and Bagchi (2012); Wang (2011); Khan et al. (2015); Amiri and Ventelou (2012); and Erkan and Yetkiner (2009) which had reported short-run bi-directional causality between increase in health expenditure and increase in economic growth. As the best of my knowledge, there has no studies estimate the Granger causality relationships between per capita tax revenue and per capita public health expenditure. Our result finds that per capita tax revenue causes to the growth of per capita public health expenditure in both short run as well as long run. While, the growth of per capita public health expenditure is not causing the growth of state's tax revenue in both short run as well as long run.

Our findings on long run causality from economic growth and tax revenue to the growth of public health expenditure have the policy implication for the sustainable health financing in India. Further, the short run bidirectional causality between public health expenditure and economic growth result implies that more investment in health sector would cause economic growth in the long run.

Table 6. *Results of VECM Granger Causality test*

	Model 1		Model 2	
Equation	Δln(PCPHE)	Δln(PCGSDP)	Δln(PCPHE)	Δln(PCTREV)
Δln(PCPHE)		0.364[a] [17.213][b] (0.004)[c*]		-0.044 [11.047] (0.026)[**]
Δln(PCGSDP)	-0.154 [50.404] (0.000)[*]			
Δln(PCTREV)			-0.025 [4.356] (0.359)	
ECM_{it-1}	0.026 [4.894] (0.000)[*]	-0.001 [-2.449] (0.014)[**]	0.001 [0.177] (0.858)	-0.070 [-6.291] (0.000)[*]

Notes: 1) [a], [b] and [c] denote the sum of coefficients, statistics value, and p-value, respectively. 2) Chi-square statistics testing for short run causality through the joint significance of Wald test, and t-statistics testing for long run causality through the error-correction adjustment coefficient. 3) [*] Statistical significant at 1 percent level, [**] Statistical significant at 5 percent level.

4. Conclusion

In this paper we examines the long run effect of GDP and tax revenue on the public health expenditure for sixteen major Indian states over the period 1980 to 2014. The main motivation of our study had based on the argument that whether the budgetary space (per capita GSDP and per capita tax revenue) of the state governments is enough for financing health care for achieving universal health coverage. We applied panel long run cointegrating estimator (FMOLS and DOLS) and panel VECM techniques for the empirical analysis.

Overall trends analysis concludes that there is a huge variation in the growth of per capita public health expenditure among the states of India. Further, lower income states are not able to mobilise more resources towards public health expenditure due to lower level of revenue growth. On the contrary higher income states are also fails to mobilise more resources towards public health expenditure despite higher level of revenue growth.

Overall, empirical analysis concludes that public health expenditure has long run relationships with the growth of per capita GSDP and per capita tax revenue. It shows that the elasticity of public health expenditure with respect to GSDP and tax revenue has less than one in the long run, exhibits health is not a luxury good in India. Further, per capita GSDP and per capita tax revenue have caused to the growth of per capita public health expenditure in the long run. While, per capita public health expenditure has not caused to the growth of per capita GSDP and per capita tax revenue in the long run. Our findings on long run causality from economic growth and tax revenue to the growth of public health expenditure have the policy implication for the sustainable health financing in India. Further, the short run bidirectional causality between public health expenditure and economic growth result implies that more investment in health sector would cause economic growth in the long run.

The policy implication would be growth is certainly important for spending in health but it requires enough revenue for transforming growth to health and vice-versa. The health sector is having huge requirement of financial resources to mitigate health related infrastructure. The state's budgetary space may not be sufficient to full fill the gap between supply and demand of the public health care. The state government should initiate the alternative source of finance such as proper utilization of central grants, generate more tax and non-tax revenue, increase tax base, reducing tax evasion and avoidance. The study has not taken into consideration the non-income determinants of the growth of public health expenditure; second, impact of alternative sources of revenue on public health expenditure also ignored. These limitations would be our future research analysis.

Notes

(1) Health system include all the activities whose primary purpose is to promote, restore or maintain health. In precisely health systems are not just concerned with improving people's health but with protecting them against the financial costs of illness. The challenge facing governments in low income countries is to reduce the regressive burden of OOP payment for health by expanding prepayment schemes, which spread financial risk and reduce the spectra of catastrophic health care expenditures (World health report, 2010).

(2) UHC provides assurance of health services to all needy people under three objectives such as equity in access, quality of health services and ensuring financial risk protection (World health report, 2010).

(3) Budgetary space (fiscal space) of a country refers to the government's ability and willingness to mobilize public revenues, which in turn allows it to spend money on public services and programs, including health. The necessity of the creation of fiscal space for the financing health care is that, the greater the fiscal space of a country, the greater the potential for public expenditure on health (Mclntyre and Kutzin, 2016).

References

Amiri, A. and Ventelou, B., 2012. Granger causality between total expenditure on health and GDP in OECD: Evidence from the Toda-Yamamoto approach. *Economics Letters,* 116(3), pp. 541-544.

Baltagi, B.H. and Francesco, M., 2010. Heath care expenditure and income in the OECD reconsidered: evidence from panel data. *Economic Modelling,* 27, pp. 804-811.

Behera, D.K. and Dash, U., 2016. Nexus between Public Health Expenditure and Income: Empirical evidence from Indian States. *Journal of Applied Economics and Science,* 6(44), pp. 1067-1077.

Bhat, R. and Nishant, J., 2006. Analysis of Public and Private Healthcare Expenditures. *Economic and Political Weekly,* 41(1), pp. 57-68.

Breitung, J., 2000. The local power of some unit root tests for panel data. In: Baltagi, B. (Ed.), Advances in Econometrics, Vol. 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels. JAI Press, Amsterdam, pp. 161-178.

Cantarero, D. and Lago-Peñas, S., 2010. The determinants of health care expenditure: a re-examination. *Applied Economics Letters,* 17(7), pp. 723-726.

Choudhury, M., 2014. Universal health coverage in India: Policy priorities for the central government. NIPFP working paper No. 010, National Institute of Public Finance and Policy. New Delhi: India.

Devlin, N. and Hansen, P., 2001. Health care expenditure and economic output: Granger causality. *Applied Economics Letters,* 8(8), pp. 561-564.

Dreger, C. and Reimers, H.-E., 2005. Health Care Expenditures in OECD Countries: A Panel Unit Root and Cointegration Analysis. IZA Discussion Paper No.1469, The Institute for the Study of Labour. Germany.

Duran, A., Joseph, K. and Nate, M., 2014. Universal coverage challenges require health system approach: the case of India. *Health Policy,* 114(2-3), pp. 269-277.

Engle, R.F. and Granger, C.W.J., 1987. Cointegration and error correction representation, estimation and testing. *Econometrica,* 55, pp. 251-76.

Erdil, E. and Yetkiner, I.H., 2009. The Granger-causality between health care expenditure and output: a panel data approach. *Applied Economics*, 41(4), pp. 511-518.

Fan, V.Y. and William, D.S., 2014. The health financing transition: A conceptual framework and empirical evidence. *Social Science & Medicine,* 105, pp. 112-121.

Farag, M., NandaKumar, A.K., Wallack, S., Hodgkin, D., Gaurner, G. and Erbil, C., 2012. The Income elasticity of health care spending in developing and developed countries. *International Journal of Health Care Finance and Economics,* 12(2), pp. 145-162.

Fisher, R.A., 1932. Statistical Methods for Research Workers, 4th Edition. Oliver & Boyd, Edinburgh.

Gerdtham, Ulf G. and Löthgren, M., 2000. On stationarity and cointegration of international health care expenditure and GDP. *Journal of Health Economics,* 19(4), pp. 461-475.

Hartwig, J., 2010. Is health capital formation good for long-term economic growth? - Panel Granger-causality evidence for OECD countries. *Journal of Macroeconomics,* 32(1), pp. 314-325.

Herwartz, H. and Theilen, B., 2003. The determinants of health care expenditure: Testing pooling restrictions in small samples. *Health Economics,* 12(2), pp. 113-124.

Hooda, S.K., 2015. Determinants of public expenditure on health in India: A panel data estimates. ISID Working Paper No.177, Institute for Studies in Industrial Development. New Delhi: India.

Im, K.S., Pesaran, M.H. and Shin, Y., 2003. Testing for unit roots in heterogeneous panels. *Journal of Econometrics,* 115(1), pp. 53-74.

Kao, C. and Chiang, M.-H., 2000. On the estimation and inference of a cointegrated regression in panel data. In: Baltagi, B.H. (Ed.), Advances in Econometrics: Nonstationary panels, panel cointegration and dynamic panels, 15, pp. 179-222.

Kao, C., 1999. Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics,* 90, pp. 1-44.

Khan, J.A.M. and Mahumud, R.A., 2015. Is healthcare a 'Necessity' or 'Luxury'? An empirical evidence from public and private sector analyses of South-East Asian countries?. *Health Economics Review,* 5(1), pp. 1-9.

Kurian, C.O., 2015. Financing healthcare for all in India: Towards a common goal. Oxfam India. New Delhi: India.

Kutzin, J., 2013. Health financing for universal coverage and health system performance: concepts and implications for policy. *Bulletin of the World Health Organization*, 91(8), pp. 602-611.

Levin, A., Lin, C.F. and Chu, C., 2002. Unit root tests in panel data: asymptotic and finite sample properties. *Journal of Econometrics,* 108(1), pp. 1-24.

MacDonald, G. and Hopkins, S., 2002. Unit root properties of OECD health care expenditure and GDP data. *Health economics,* 11(4), pp. 371-376.

Maddala, G.S. and Wu, S., 1999. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics,* 61(1), pp. 631-652.

Mathauer, I. and Guy, C., 2011. The role of institutional design and organizational practice for health financing performance and universal coverage. *Health policy,* 99(3), pp. 183-192.

McCoskey, S.K. and Selden, T.M., 1998. Health care expenditure and GDP: panel data unit root test results. Journal of Health Economics. 17(3), pp. 369-376.

McIntyre, D. and Kutzin, J., 2016. Health financing country diagnostic: a foundation for national strategy development. World Health Organization, Geneva: Switzerland.

Narayan, S., Narayan, P.K. and Mishra, S., 2010. Investigating the relationship between health and economic growth: Empirical evidence from a panel of 5 Asian countries. *Journal of Asian Economics,* 21(4), pp. 404-411.

Pedroni, P., 1999. Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics,* 61(1), pp. 653-670.

Pedroni, P., 2000. Fully modified OLS for heterogeneous cointegrated panels. Advances in Econometrics 15, pp. 93-130.

Pedroni, P., 2004. Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to PPP hypothesis: new results. *Econometric Theory,* 20(3), pp. 597-625.

Pradhan, R.P. and Bagchi, T.P., 2012 Economic growth and health in India: a panel cointegration assessment, *Int. J. Healthcare Technology and Management*, 13 (4), pp. 223-241.

Rahman, T., 2008. Determinants of public health care expenditure: some evidence from Indian states. *Applied Economics Letters,* 15(11), pp. 853-857.

Reeves, A., Yannis, G., Sanjay, B., McCoy, D., McKee, M. and Stuckler, D., 2015. Financing universal health coverage – effects of alternative tax structures on public health system: cross national modelling in 89 low income and middle income countries. *The Lancet,* 386 (9990), pp. 274-280.

Reserve Bank of India, 2015. Handbook of Statistics on Indian Economy. DOI: <https://www.rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20Economy>).

Sen, A., 2005. Is health care a luxury? New evidence from OECD data. *International Journal of Health Care Finance and Economics,* 5 (2), pp. 147-164.

State Finances study of Budgets, 2015. Reserve Bank of India Data base. DOI: <https://www.rbi.org.in/Scripts/AnnualPublications.aspx?head=State%20Finances%20:%20A%20Study%20of%20Budgets>

Tamakoshi, T. and Shigeyuki, H., 2014. Health-care expenditure, GDP and share of the elderly in Japan: a panel cointegration analysis. *Applied Economics Letters,* 22(9), pp. 725-729.

Wang, K.M., 2011. Health care expenditure and economic growth: Quantile panel-type analysis. *Economic Modelling,* 28(4), pp. 1536-1549.

Wang, Z., 2009. The determinants of health care expenditure: evidence from US state level data. *Applied Economics,* 41 (4), pp. 429-435.

World Health Organization, 2010. The world health report 2000: health systems financing path to universal coverage. World Health Organization, Geneva: Switzerland.

Appendix

Table A1. Lag length criteria for VECM Granger Causality

Lag order	LogL	LR	FPE	AIC	SC	HQ
Model 1						
0	-489.622	NA	0.028533	2.119061	2.136906	2.126086
1	1084.451	3127.792	3.28e-05	-4.6485	-4.59496	-4.62742
2	1118.571	67.50519	2.88e-05	-4.77832	-4.689102*	-4.7432
3	1123.974	10.64296	2.87e-05	-4.78437	-4.65946	-4.7352
4	1142.168	35.68253	2.70e-05	-4.84555	-4.68495	-4.78234
5	1153.688	22.49364*	2.61e-05*	-4.877967*	-4.68168	-4.800701*
6	1157.124	6.678933	2.62e-05	-4.87553	-4.64356	-4.78422
Model 2						
0	-651.935	NA	0.057437	2.818684	2.836528	2.825708
1	880.2060	3044.469	7.92e-05	-3.76813	-3.714596*	-3.747057*
2	881.6377	2.832699	8.01e-05	-3.75706	-3.66784	-3.72194
3	888.6449	13.80293	7.90e-05	-3.77002	-3.64511	-3.72085
4	897.3908	17.15258*	7.74e-05*	-3.790478*	-3.62988	-3.72726
5	898.4888	2.143878	7.84e-05	-3.77797	-3.58168	-3.7007
6	900.5181	3.944866	7.91e-05	-3.76948	-3.5375	-3.67816

Notes: 1) * indicates lag order selection by the criterion. 2) LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.