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DETERMINANTS OF INDIA'S HEALTH EXPENDITURE: AN ECONOMETRIC ANALYSIS

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ABSTRACT

Human capital is the key factor of economic development where government expenditure on health care is the dominant variable by which GDP per capita, human development, emission per capita, education expenditure and other prime factors of health economics depend upon. The paper explores the short run and long run causalities among them through cointegration and vector error correction analysis in India during 1990-2017. The paper also finds out the behavior of India's health expenditure percent of GDP during 1990-2017 using polynomial regression, structural breaks, H.P. filter and ARIMA models. The paper concludes that the health expenditure of India is polynomial in character during 1990-2017 which have two upward and downward structural breaks. Health expenditure has long run association with HDI, GDP per capita, CO_2 emissions per capita, energy use, life expectancy at birth and education expenditure as per cent of GDP during the same period. Health expenditure has long run causalities from CO_2 emission per capita, energy use, life expectancy at birth and education expenditure in India respectively but has short run causalities from HDI, life expectancy and education expenditure. Even there is short run causality from health expenditure to education expenditure as percent of GDP. Two significant cointegrating equations converge to equilibrium. VECM states that the change of health expenditure percent of GDP was positively associated with previous year change of GDP per capita and life expectancy at birth significantly and negatively related with previous year changes of HDI and education expenditure percent of GDP in India during 1990-2017. The VECM is unstable and non-stationary and suffers from autocorrelation problem. The impulse response functions conclude that the responses of health expenditure percent of GDP to energy use, life expectancy at birth and education expenditure percent of GDP move to equilibrium.

Keywords: GDP Per Capita, HDI, CO_2 Emission Per Capital, Cointegration, Vector Error Correction, Short & Long Run Causality

INTRODUCTION

Health is the important determinant of economic development. A healthy population indicates higher productivity, thus higher income per head. Uzawa (1965), Lucas (1988) and Romer (1990) emphasized that human capital development which is the key factor of economic plan is positively associated with economic growth. Thus, investment in human capital education, health, and training play an important role as an incentive for them to increase their earnings in future (Becker, 1994). Investment in health can lead to an increase in productivity which imply increase in income and this incentive develops new skill and knowledge to higher level. A higher expenditure in health leads to reduce in infant mortality rate which implies to hike literacy rate and per capita GDP and leads to higher human development index.

There is much consideration that health care facility plays an important role in the stability of climate change. Concern for health has traditionally undertaken much of the political priority compared to environmental issues across the world. Poor environmental quality is responsible for many health damages and air, water, and soil pollution can increase the risks of illness. The share of government spending on health is constantly increasing and is met by an almost immediate increase in the demand for health care. The increasing determination in emission quality across the world is posing serious challenges to healthy living through the increasing threat of global warming.

The green logistic activities are well-associated with trade and economic growth while polluted logistical operations will lead to increase in carbon emissions and health expenditure. The global logistics operations and vehicles are mainly dependent on fossil fuels. Hence the analysts require comprehensive knowledge of biofuels and green energy sources which would considerably mitigate negative impacts of logistic operations on environmental beauty and human health.

United Nations (2012) rightly emphasized that action of health both for poor and for the entire population is important to create inclusive, equitable, economically productive, and healthy societies. WHO (2016) formulated the objectives for linking between investments in health workforce and improvements in health outcomes, social welfare, employment creation and economic growth and argued that investment in human resources for health can deliver a triple return of improved health outcomes, global health security and economic development. UNCTAD also provided technical assistance to developing countries to sanction investment in domestic public health systems to ensure sustainable development goal 3 through its investment and public health programme.

LITERATURE REVIEW

The role of health in influencing economic activities at micro level has been explained by Strauss & Thomas (1998) and Shultz (1999). The human capital theory based on Grossman (1972) gave light on both endogenous and exogeneous variables which have an impact on health. The demand function approach found a strong and positive relationship between national income and health care expenditure (Kleiman, 1974; Leu, 1986; Hitiris & Posnett,1992, Filmer & Pritchett, 1999). Gerdtham *et al.*, (1992) found the income elasticity of per capita health expenditure was greater than one implying that health care is a luxury good rather than a necessity. Duraisamy & Mahal (2005) examined the determinants of economic growth and health using panel data of 14 major Indian states for the period 1970-71-2000-01 and found two-way causalities between economic growth and health status. Bhowmik (2019) verified econometrically in ASEAN-7 during 1990-2016 in panel data and found that there are long run causalities from GDP, HDI and unemployment rate to health expenditure as percent of GDP and there is short run causality from health expenditure to GDP of ASEAN-7.

Wang (2015) verified that when the ratio of health spending to GDP is less than the optimal level of 7.55%, an increase in health spending effectively lead to better economic performance by applying GMM in OECD countries during 1990-2009. Wilson (1995) examined the relationship between medical care expenditure and GDP growth in OECD countries and found a bidirectional causality between them. Tekabe (2012) studied 47 African South of Saharan countries during 1970-2009 using panel data in Granger causality test and found that there is a causal relationship between per capita income and health expenditure in Ethiopia, Kenya, Rwanda, Tanzania, and Uganda. Mirahsani (2016) examined the relationship between human development index and health expenditure as a ratio of GDP in 25 South West Asian countries during 2000-2009 through OLS method with F test and found that the relationship is positive and significant. Razmi, Abbasian & Mohammadi (2012) examined in Iran from 1990 to 2009 by OLS method and found that there was a significant positive relation between government health expenditure and human development index.

Yahaya *et al.*, (2016) verified in 125 developing countries from 1995 to 2012 among per capita expenditure, carbon mono-oxide, nitrogen oxide, sulphur oxide and found that they are cointegrated and they have short run and long run impacts on per capita health expenditure which are increasing over time. Apergis, Jebli & Youssef (2015) examined in 42 Sub-Saharan countries during 1995-2011 and showed long run causalities among renewable energy consumption and health expenditure and found unidirectional causality from real GDP to health expenditure. Polat & Ergun (2018) empirically verified one-way causality from health expenditure to economic growth and CO_2 emission in Turkey during 1980-2016. Yazdi & Khanalizadeh (2017) verified that the health expenditure, income, carbon dioxide and PM10 emissions are cointegrated and they have positive impact on health expenditure in the Middle East and North African countries during 1995-2014. Abdullah, Azam & Zakariya (2016) verified that there is long run relationship of health expenditure with GDP, CO_2, NO_2, SO_2 emissions, mortality rate, fertility rate, and infant mortality rate in Malaysia from 1970 to 2014. The impact is negative in the long run but positive in the short run. Khan, Thomas & Senga (2019) studied empirically in ASEAN using SEM during 2007-2017. He found that public health expenditure and environmental performance is negatively correlated which implies that greater environmental sustainability with lower CO_2 emissions and GHGs will improve human health and economic growth.

Oni (2014) explained that a country's total health expenditure, labor force productivity and gross capital formation are significant indicators of the country's economic development in the context of Nigeria, but poor health of workers and life expectancy rate are negatively affected on economic growth.

Objectives of the paper

The paper seeks to explore the short run and long run causalities among the health expenditure percent of

GDP, Human Development Index, GDP per capita at current price in US Dollar, CO_2 emission per capita in metric tons, energy use in Kg of oil equivalent per capita, Life expectancy at birth, and the education expenditure percent of GDP respectively in India from 1990 to 2017. It also searched the cointegrating relationships and vector error correction analysis among them where Wald test for short run causality, Hansen-Doornik normality test and stability and stationery of the VECM were verified. The paper tried to examine the nature and the characteristics of the series through semi-log regression, Bai-Perron model and H.P. Filter model.

RESEARCH METHODOLOGY

Assume, Y= health expenditure percent of GDP, x_1= Human Development Index, x_2=GDP per capita at current price in US Dollar, x_3= CO_2 emission per capita in Mt, x_4=energy use in Kg of oil equivalent per capita, x_5= Life expectancy at birth, x_6= education expenditure percent of GDP. The data on x_2, x_3, x_4, x_5, have been collected from the World Bank. The data on y were available from WHO and the world Bank. The data on x_6 were collected from CSO and the World Bank.

The trend line was calculated by using semi-log linear regression equation. Structural breaks of the series were found from the Bai-Perron model (2003). The cyclical trends were normalised by applying H.P. Filter model (Hodrick & Prescott, 1997). Double-log multiple regression model was used to show economic relationships among the variables. Johansen model (1988) was applied to find out cointegration and vector error correction analysis. Doornik-Hansen (2008) model was utilised to check the normality. Short run causalities among the variables were verified through the Wald test (1943).

Econometric Observations

The health expenditure as percent of GDP in India from 1990 to 2017 has not been increasing steadily over time but it is increasing followed by declining and again it is rising which implies that it is a polynomial in shape and is estimated below:

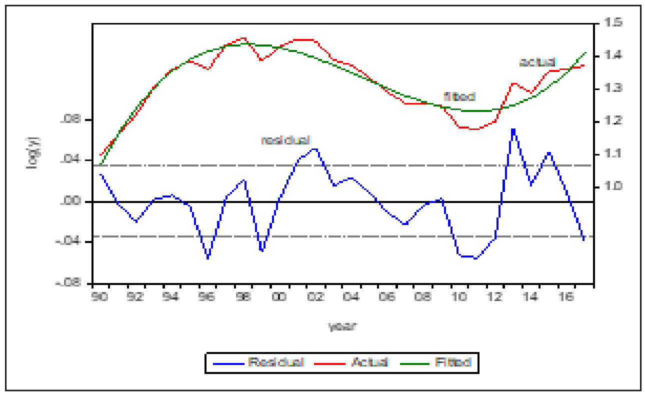
$$Log(y)=0.9612+0.000197t^3-0.00921t^2+0.1198t$$

$$(31.67)^* \quad (12.26)^* \quad (-13.03)^* \quad (13.46)^*$$

R^2=0.0.88, F=61.36*, DW=1.49

This estimated equation is plotted below where the health expenditure of India is inverse S- shaped which satisfied the estimated equation (refer to figure 1).

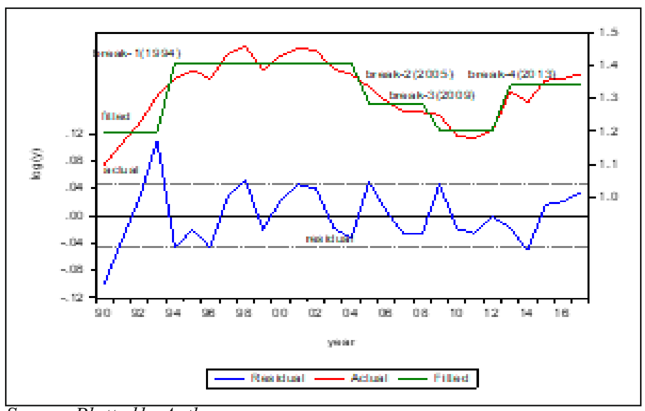
Figure 1: The Estimated Trend of Health Expenditure



Source- Plotted by Author

The health expenditure as percent of GDP in India during 1990-2017 has four structural breaks in 1994, 2005, 2009 and 2013, respectively. The first break is upward, second and third breaks are downward, and the fourth break is upward. All are significant at 5% level, R^2=0.802, F=23.407* and DW=1.68. The breaks have been seen in the figure 2 distinctly.

Figure 2: Structural Breaks



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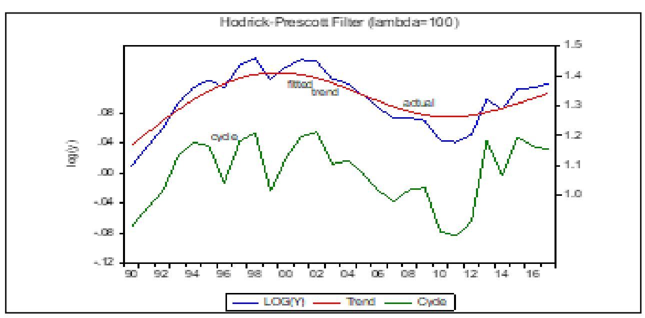
H.P. Filter model (where lamda=100, and HAC standard) verified that the fitted cycle of the estimated function of health expenditure is upward and then downward followed by upward shape which is plotted in figure 3.

Figure 3: HP Filter Model of Health Expenditure



Source- Plotted by Author

ARIMA (1,1,1) model states that the health expenditure percent of GDP in India during 1990-2017 has significant autoregressive convergence (z value significant) and insignificant moving average convergence (z value insignificant), so that the convergence of the model is insignificant whose estimated equation is given below. It is also non-stationery and unstable since roots are greater than one.

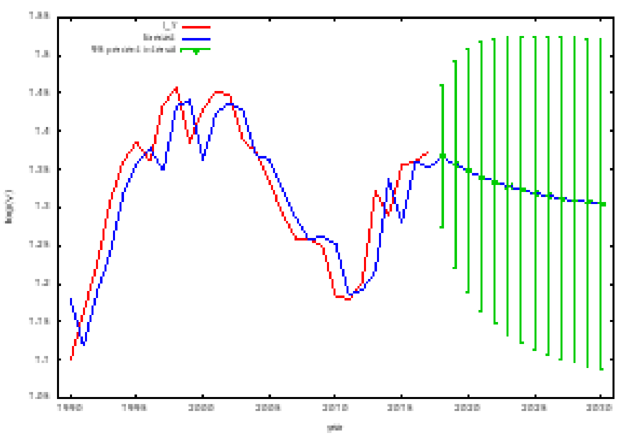
$$\text{Log}(y_t)=1.2909+0.8679\log(y_{t-1})+\varepsilon_t+0.19678\varepsilon_{t-1}$$

(18.83)* (7.96)* (1.107)

AR root=1.1521, MA root=-5.2416, SC=-76.24, AIC=-61.57

But the forecast model of ARIMA (1,1,1) for 2030 has been converging which is significant at 5% level and is seen by downward green line up to 2030 in figure 4 below.

Figure 4: Forecast for Log(y)



Source- Plotted by Author

Double log multiple regression analysis states that [i] one percent increase in human development index led to increase in health expenditure by 0.00108 percent per year, [ii] one percent rise in GDP per capita reduces 0.5134 percent in health expenditure per year, [iii] one percent increase in CO_2 emission per capita led to increase in health expenditure by 0.4027 percent per year, [iv] one percent hike in energy use per year would decrease in health expenditure by 0.4658 percent per year, [v] one percent rise in life expectancy per year leads to 0.0798 percent increase in health expenditure per year, and [vi] one percent increase in education expenditure per year will lead to 5.34 percent increase in health expenditure as per cent of GDP per year respectively during 1990-2017. The results are highly significant with high R^2, F and DW.

$$\text{Log}(y)= -14.81747+0.00108\log(x_1)\ 0.51346\log(x_2)$$

(-4.33)* (0.141) (-5.14)*

$$+0.40279\log(x_3)-0.46583\log(x_4)+0.0798\log(x_5)$$

(1.84)* (-1.09) (1.80)*

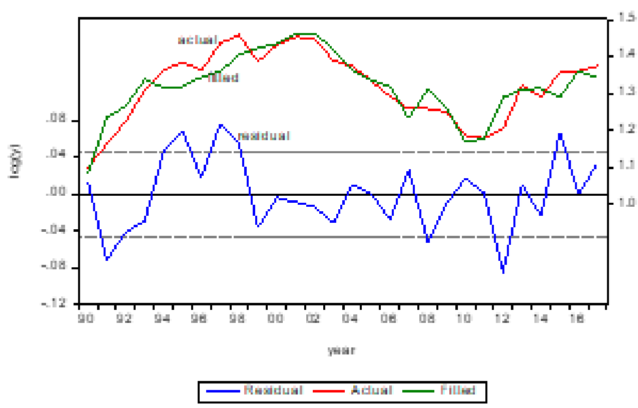
$$+5.3449\log(x_6)$$

(6.53)*

R^2=0.825, F=16.51* DW=1.71, *=significant at 10% level

In figure 5, the diagrammatical representation explains that the fitted and actual lines crossed several times and move away from equilibrium.

Figure 5: Actual and Fitted Regression Lines



Source- Plotted by Author

Johansen Unrestricted Cointegration Rank test of the first difference series of log health expenditure, human development index, GDP per capita, CO_2 emission per capita, energy use, life expectancy at birth and education expenditure of India during 1990-2017 assuming quadratic deterministic trend verified that they are cointegrated and have long run association among them because the Trace statistic contains five cointegrating equations and Max Eigen statistic contains three cointegrating equations which are significant at 5% level. Their values are given in the table 1.

Table 1: Johansen Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.994734	349.4178	139.2753	0.0000
At most 1 *	0.965817	213.0074	107.3466	0.0000
At most 2 *	0.889674	125.2305	79.34145	0.0000
At most 3 *	0.669177	67.91816	55.24578	0.0026

At most 4 *	0.615186	39.15767	35.01090	0.0170
At most 5	0.407224	14.32778	18.39771	0.1692
At most 6	0.027738	0.731367	3.841466	0.3924
Hypothesized No. of CE(s)	**Eigenvalue**	**Max Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.994734	136.4105	49.58633	0.0000
At most 1 *	0.965817	87.77693	43.41977	0.0000
At most 2 *	0.889674	57.31229	37.16359	0.0001
At most 3	0.669177	28.76050	30.81507	0.0874
At most 4 *	0.615186	24.82989	24.25202	0.0419
At most 5	0.407224	13.59641	17.14769	0.1529
At most 6	0.027738	0.731367	3.841466	0.3924

Source-Calculated by Author

* denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) *p*-values

The regression equations of Vector Error Correction Model have been tabulated below:

In the table 2, the estimated equation states that [i] The change of health expenditure percent of GDP was positively associated with previous year changes of GDP per capita and life expectancy at birth significantly and also negatively related with previous year changes of HDI and education expenditure percent of GDP in India during 1990-2017, [ii] The change of GDP per capita is positively associated with the change of education expenditure of earlier period significantly, [iii] The change of CO_2 emission per capita is negatively related with previous year changes in GDP per capita and life expectancy at birth significantly, [iv] The change of energy use is affected negatively by the previous year changes in GDP per capita and life expectancy at birth significantly and affected positively by previous year change in education expenditure percent of GDP respectively, [v] The change of education expenditure percent of GDP is negatively associated with previous year changes in HDI, CO_2 emission per capita and life expectancy at birth and is positively related with previous year change of energy use respectively at 5% significant level in India during the specified period.

Table 2: VECM

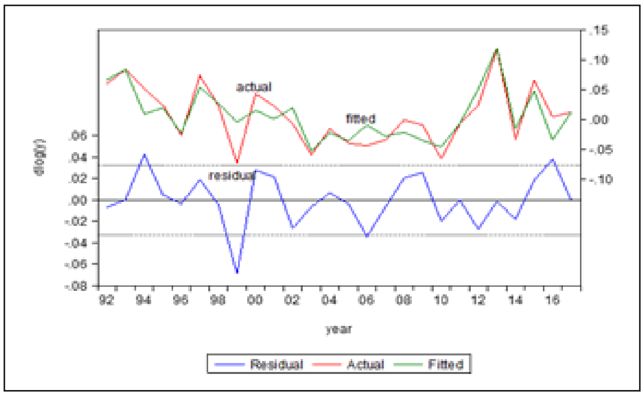
Error Correction:	Δlog(Y)	Δlog(X_1)	Δlog(X_2)	Δlog(X_3)	Δlog(X_4)	Δlog(X_5)	Δlog(X_6)
CointEq1	-0.456170	-2.367777	0.512580	-0.036746	0.115241	-0.814960	-0.002735
t value	[-2.31979]*	[-0.32870]	[1.39278]	[-0.18163]	[1.60702]	[-0.76412]	[-7.87609]*
CointEq2	1.502043	7.519403	-1.536557	0.024910	-0.366580	2.080861	0.009550
t value	[2.27183]*	[0.31046]	[-1.24177]	[0.03662]	[-1.52038]	[0.58028]	[8.17778]*
CointEq3	-0.176892	0.086473	-0.059719	0.378812	0.050025	0.694283	-0.000195
t value	[-1.76877]	[0.02360]	[-0.31906]	[3.68175]*	[1.37164]	[1.27998]	[-1.10595]
ΔlogY(-1)	0.383787	4.596160	-0.755058	0.034984	-0.131694	0.989610	8.37E-05
t value	[1.64944]	[0.53923]	[-1.73391]	[0.14614]	[-1.55204]	[0.78417]	[0.20357]
ΔlogX_1(-1)	-1.537899	-8.127168	1.573539	0.049872	0.369578	-2.064419	-0.009506
t value	[-2.31840]*	[-0.33445]	[1.26747]	[0.07308]	[1.52776]	[-0.57380]	[-8.11319]*
ΔlogX_2(-1)	0.319551	-1.241362	-0.459112	-0.345656	-0.123326	0.486525	0.000194
t value	[2.09326]*	[-0.22198]	[-1.60695]	[-2.20087]*	[-2.21528]*	[0.58761]	[0.71923]
ΔlogX_3(-1)	0.440546	-22.56566	-1.442449	-0.278049	0.088826	3.589846	-0.003376
t value	[1.13215]	[-1.58305]	[-1.98068]	[-0.69455]	[0.62595]	[1.70095]	[-4.91206]*
ΔlogX_4(-1)	-1.199377	20.08777	2.304773	0.131229	-0.285738	-7.009035	0.006190
t value	[-1.73724]	[0.79427]	[1.78374]	[0.18476]	[-1.13491]	[-1.87182]	[5.07667]*
ΔlogX_5(-1)	0.192137	0.234275	-0.114653	-0.151633	-0.047374	-0.427883	-0.000244
t value	[3.29009]*	[0.10951]	[-1.04902]	[-2.52381]	[-2.22449]*	[-1.35091]	[-2.36092]*
ΔlogX_6(-1)	-132.6622	-990.6792	182.5092	105.2064	68.73574	-147.2681	0.867152
t value	[-3.17844]*	[-0.64793]	[2.33642]*	[2.45006]*	[4.51585]*	[-0.65055]	[11.7630]*
C	0.272792	3.908057	-0.580924	-0.856033	-0.352735	-0.028020	-0.004427
t value	[1.18093]	[0.46183]	[-1.34374]	[-3.60207]*	[-4.18730]*	[-0.02236]	[-10.8512]*
@Trend (90)	0.072069	0.376141	-0.067436	0.014125	-0.012214	0.109995	0.000537
t value	[2.05254]*	[0.29243]	[-1.02621]	[0.39101]	[-0.95389]	[0.57758]	[8.66161]*
R-squared	0.754973	0.794398	0.607803	0.769980	0.778186	0.544548	0.998647
F-statistic	3.921506	4.917529	1.972393	4.260389	4.465092	1.521701	939.4345
Akaike AIC	-3.721243	3.480638	-2.467717	-3.664448	-5.738724	-0.339678	-16.39907
Schwarz SC	-3.140583	4.061298	-1.887057	-3.083788	-5.158064	0.240982	-15.81841

Source- Calculated by Author

**= significant at 5% level*

The relationships in VECM-1 where health expenditure per cent of GDP was established have been marching towards equilibrium where the fitted and actual lines crossed several times which are seen in the figure 6.

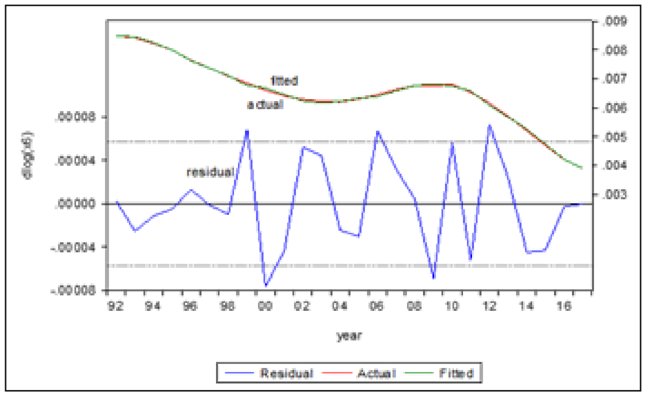
Figure 6: VECM-1



Source- Plotted by Author

Similarly, the relationships in VECM-7 where the education expenditure percent of GDP was established have been moving towards equilibrium where actual and fitted lines crossed many times which was visible in the figure 7.

Figure 7: VECM-7



Source- Plotted by Author

The VECM found three normalised cointegrating equations which have been shown in table 3.

Table 3: Normalised Cointegrating Equations

	Logy (-1)	$Logx_1(-1)$	$Logx_2(-1)$	$Logx_3(-1)$	$Logx_4(-1)$	$Logx_5(-1)$	$Logx_6(-1)$	@trend90	c
CointEq1	1.0	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
				2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	1.0	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
				2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	1.0	-4.318	-2.749	0.769	48.525		
				-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

Based on the system equations in the VECM, the estimated cointegrating equations have been arranged below:

Table 4: Estimated Cointegrated Equations in the System Equation- 1

	Logy(-1)	$Logx_1(-1)$	$Logx_2(-1)$	$Logx_3(-1)$	$Logx_4(-1)$	$Logx_5(-1)$	$Logx_6(-1)$	@trend90	c
CointEq1	-0.4561	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
	-2.31*			2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	1.50204	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
		2.27*		2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	-0.17689	-4.318	-2.749	0.769	48.525		
			-1.76	-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

Table 5: The Estimated Cointegrated Equations in the System Equation- 2

	Logy(-1)	$Logx_1(-1)$	$Logx_2(-1)$	$Logx_3(-1)$	$Logx_4(-1)$	$Logx_5(-1)$	$Logx_6(-1)$	@trend90	c
CointEq1	-2.3677	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
	-0.328			2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	7.5194	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
		0.3104		2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	0.08647	-4.318	-2.749	0.769	48.525		
			0.0236	-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

Table 6: The Estimated Cointegrating Equations in the System Equation- 3

	Logy(-1)	Logx1(-1)	Logx2(-1)	Logx3(-1)	Logx4(-1)	Logx5(-1)	Logx6(-1)	@trend90	c
CointEq1	0.51258	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
	1.39			2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	-1.5365	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
		-1.241		2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	-0.0597	-4.318	-2.749	0.769	48.525		
			-0.319	-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

Table 7: The Estimated Cointegrating Equations in the System Equation- 4

	Logy(-1)	Logx1(-1)	Logx2(-1)	Logx3(-1)	Logx4(-1)	Logx5(-1)	Logx6(-1)	@trend90	c
CointEq1	-0.03674	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
	-0.181			2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	0.02491	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
		0.0366		2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	0.3788	-4.318	-2.749	0.769	48.525		
			3.681*	-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

Table 8: The Estimated Cointegrating Equations in the System Equation- 5

	Logy(-1)	Logx1(-1)	Logx2(-1)	Logx3(-1)	Logx4(-1)	Logx5(-1)	Logx6(-1)	@trend90	c
CointEq1	0.11512	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
	1.607			2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	-0.36658	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
		-1.52		2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	0.050025	-4.318	-2.749	0.769	48.525		
			1.371	-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

Table 9: The Estimated Cointegrating Equations in the System Equation- 6

	Logy(-1)	Logx1(-1)	Logx2(-1)	Logx3(-1)	Logx4(-1)	Logx5(-1)	Logx6(-1)	@trend90	c
CointEq1	-0.81496	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
	-0.764			2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	2.0808	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
		0.580		2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	0.69428	-4.318	-2.749	0.769	48.525		
			1.279	-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

Table 10: The Estimated Cointegrating Equations in the System Equation- 7

	Logy(-1)	Logx1(-1)	Logx2(-1)	Logx3(-1)	Logx4(-1)	Logx5(-1)	Logx6(-1)	@trend90	c
CointEq1	-0.00273	0.0	0.0	14.550	-62.981	2.7084	-223.98	2.570	1274.08
	-7.87*			2.12*	-7.45*	3.80*	-3.07*		
CointEq2	0.0	0.00955	0.0	4.443	-19.188	0.810	-64.770	0.684	375.98
		8.177*		2.23*	-7.80*	3.91*	-3.05*		
CointEq3	0.0	0.0	-0.00019	-4.318	-2.749	0.769	48.525		
			1.105	-4.62*	-2.14*	7.91*	4.87*		

Source- Calculated by Author

*=significant at 5% level (for Table 4-10)

The above estimated cointegrating equations of all the system equations explained that the cointegrating equations number one in system equations one and seven in table 4 to 10, have been approaching towards equilibrium significantly because *t* values of the coefficients logy(-1) are significant. Moreover, the cointegrating equation one of the system equation 2, 4, and 6 cointegrating equations no 2 of the system equations 3, and 5 and cointegrating equation 3 of the system equations 1, 3, and 7 have been moving towards equilibrium insignificantly since all *t* values of the coefficients are not significant at 5% level. All these implied that there are long run causalities running from CO_2 emission per capita, energy use, life expectancy at birth and education expenditure percent of GDP to the health expenditure percent of GDP in India during 1990-2017. In addition to that the long run causalities were found from CO_2 emission per capita, energy use, life expectancy at birth and education expenditure percent of GDP to the health expenditure percent of GDP and to the education expenditure percent GDP in India during 1990-2017.

In table 11, the Wald test has been checked on the coefficients of the system equations of VECM from which it is found that [i] There are short run causalities from HDI, life expectancy at birth, and education expenditure percent of GDP to the health expenditure percent of GDP in India, [ii] Short run causalities were found from CO_2 emission per capita and education expenditure percent of GDP to GDP per capita, [iii] There are short run causalities running from GDP per capita, life expectancy at birth, and education expenditure percent of GDP to the CO_2 emission per capita, [iv] Short run causalities were seen from GDP per capita, life expectancy at birth and education expenditure percent GDP to the energy use, [v] There is short run causality from energy use to life expectancy at birth, [vi] There are short run causalities running from health expenditure percent of GDP, CO_2 emission per capita, energy use and life expectancy at birth to education expenditure percent of GDP in India.

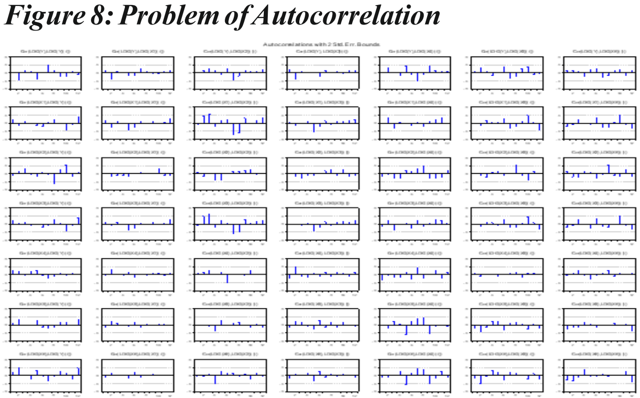
Table 11: Short Run Causality

Short run causality from …………….to……	Chi-square(1)	Prob	H_0=no causality
Short run causality from HDI to health expenditure % GDP	5.3749	0.0204	Rejected
Short run causality from life expectancy to health expenditure % GDP	10.8246	0.0016	Rejected
Short run causality from education expenditure % GDP to health expenditure % GDP	10.10248	0.0015	Rejected
Short run causality from CO_2 emission per capita to GDP per capita	3.9291	0.0476	Rejected
Short run causality from education expenditure % GDP to GDP per capita	5.4588	0.0195	Rejected
Short run causality from GDP per capita to CO_2 emission per capita	4.8438	0.0277	Rejected
Short run causality from life expectancy to CO_2 emission per capita	6.3696	0.0116	Rejected
Short run causality from education expenditure % GDP to CO_2 emission per capita	6.0027	0.0143	Rejected
Short run causality from GDP per capita to energy use	4.90746	0.0267	Rejected
Short run causality from life expectancy to energy use	4.9483	0.0261	Rejected
Short run causality from education expenditure % GDP to energy use	20.3929	0.0000	Rejected
Short run causality from energy use to life expectancy	3.50372	0.0612	Rejected at 6% level
Short run causality from health expenditure % GDP to education expenditure % GDP	65.8239	0.0000	Rejected
Short run causality from CO_2 emission per capita to education expenditure % GDP	24.1283	0.0000	Rejected
Short run causality from energy use to education expenditure % GDP	25.7725	0.0000	Rejected
Short run causality from life expectancy to education expenditure % GDP	5.5739	0.0182	Rejected

Source- Calculated by Author

The residual test for the problem of autocorrelation verified that the VECM contains autocorrelation since the figure 8 showed vertical lines having autocorrelation with 2SE bounds in each correlogram.

Figure 8: Problem of Autocorrelation



Source- Calculated by Author

Residual correlation of Doornik-Hansen VEC normality test showed that Chi-square values of each component of skewness and components 5, 6 and 7 of kurtosis and all components of Jarque Bera have been accepted for normality but others are rejected. Therefore, VECM is not normally distributed (refer to table 12).

Table 12: VEC Normality Test

Component	Skewness	Chi-square	Degree of Freedom	Probability
1	-0.109276	0.073122	1	0.7868
2	-0.145630	0.129576	1	0.7189
3	0.056461	0.019562	1	0.8888
4	0.030489	0.005708	1	0.9398
5	0.094935	0.055228	1	0.8142
6	0.772157	3.225808	1	0.0725
7	0.173474	0.183468	1	0.6684
Joint		3.692470	7	0.8144

Component	Kurtosis	Chi-square	Degree of Freedom	Probability
1	3.887991	4.990629	1	0.0255
2	3.943410	5.200850	1	0.0226
3	3.802637	4.614221	1	0.0317
4	3.895949	5.151462	1	0.0232
5	3.096404	1.333344	1	0.2482
6	2.945128	0.757764	1	0.3840
7	2.035788	0.898611	1	0.3432
Joint		22.94688	7	0.0017
Component	**Jarque-Bera**	**Degree of Freedom**	**Probability**	
1	5.063751	2	0.0795	
2	5.330426	2	0.0696	
3	4.633783	2	0.0986	
4	5.157170	2	0.0759	
5	1.388571	2	0.4994	
6	3.983571	2	0.1365	
7	1.082079	2	0.5821	
Joint	26.63935	14	0.0214	

Source- Calculated by Author

If there is no unit root in the AR characteristic polynomial then VECM will be stable model but it contains 4 roots greater than unity, 4 roots are unity, one root is positive, and less than one and 3 roots are negative. Thus, VECM is unstable (refer to table 13).

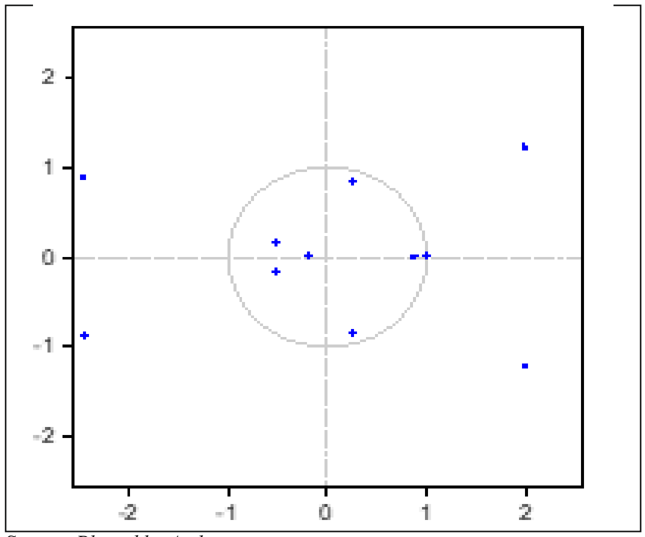
Table 13: Roots of VECM

Root	Modulus
-2.459933 + 0.877731i	2.611835
1.997029 - 1.218834i	2.339589
1.997029 + 1.218834i	2.339589
1.000000	1.000000
1.000000 - 1.01e-15i	1.000000
1.000000 + 1.01e-15i	1.000000
1.000000	1.000000
0.259803 - 0.841276i	0.880478
0.259803 + 0.841276i	0.880478
0.878642	0.878642
-0.509748 - 0.161045i	0.534583
-0.509748 + 0.161045i	0.534583
-0.187056	0.187056

Source- Calculated by Author

These roots have been plotted in the unit circle where 4 roots lie outside the unit circle and other roots lie on or inside the unit circle which means the model is nonstationary and unstable (refer to figure 9).

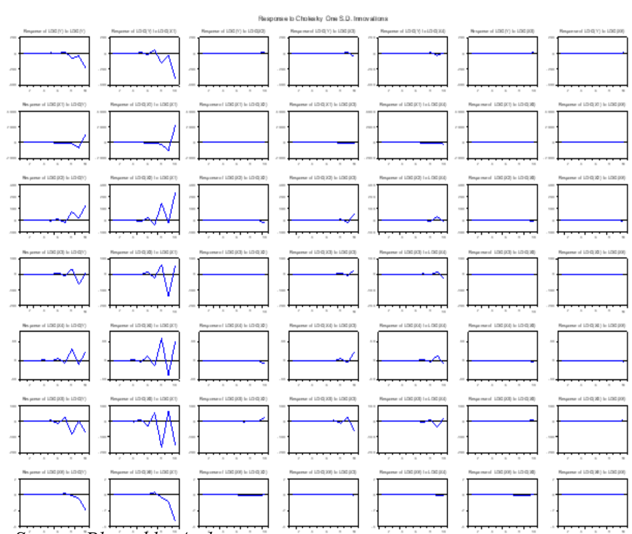
Figure 9: Unit Circle



Source- Plotted by Author

The impulse response functions of responses to Cholesky one standard deviation innovations examined that the responses of health expenditure percent of GDP to energy use, life expectancy at birth and education expenditure percent of GDP move to equilibrium. The responses of human development index to GDP per capita, CO_2 emission per capita, life expectancy at birth and education expenditure tend to equilibrium. The responses of CO_2 emission per capita to life expectancy at birth and education expenditure approach to equilibrium. And the responses of education expenditure percent of GDP to GDP per capita, CO_2 emission per capita, energy use and life expectancy at birth tend to equilibrium (Figure 10).

Figure 10: Impulse Response Functions



Source- Plotted by Author

Limitations and future scope of research

The paper excluded some crucial variables such as fertility rate, infant mortality rate, death rate and birth date which had important implications of health expenditure in India. There is a positive cointegration between labor productivity and health expenditure that might reduce unemployment rate, but the paper did not include such areas of explanations. The human development index of India during 1990-2017 is negatively related with health expenditure which is an exception because of polynomial character of the health expenditure in India. This relationship is the prime constraint here to get favorable empirical evidences in order to execute policy formulations. It is expected that the paper produces ample scope for forthcoming research and might overcome such limitations.

Important policy considerations

The basic criteria were to step up education and health expenditure steadily by which HDI and GDP per capita might increase constantly that could reduce emissions per capita, unemployment rate, but India had failed to do so. Secondly, private health care services in India have flourished more than government initiatives in medical care which reduced the government health expenditure percent of GDP. If India targets to achieve sustainable development goals, then it should plan to increase in productivity of labor and employment through the steady rise in health expenditure. The emission control board and good emission policies are needed to check adverse impact on human capital immediately. Government should provide health care as a public service which seems to commit to the citizens not emphasizing it as a corporate social responsibility.

CONCLUSION

The paper concludes that the health expenditure of India is polynomial in character during 1990-2017 which have two upward and downward structural breaks. Health expenditure as percent of GDP in India has long run association with HDI, GDP per capita, CO_2 emissions per capita, energy use, life expectancy at birth and education expenditure as percent of GDP during the same period. Health expenditure has long run causalities from CO_2 emission per capita, energy use, life expectancy at birth and education expenditure in India respectively but has short run causalities from HDI, life expectancy and education expenditure. Even there is short run causality from health expenditure to education expenditure as percent of GDP. Two significant cointegrating equations tend to equilibrium. VECM states that the change of health expenditure percent of GDP was positively associated with previous year changes of GDP per capita and life expectancy at birth significantly and negatively related with previous year changes of HDI and education expenditure percent of GDP in India during 1990-2017. The VECM is unstable and non-stationary and suffers from autocorrelation problem. The impulse response functions conclude that the responses of health expenditure percent of GDP to energy use, life expectancy at birth and education expenditure percent of GDP move to equilibrium.

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