DOES ECONOMIC GROWTH HAS ANY RELATIONSHIP WITH HEALTH STATUS IN INDIA - AN EMPIRICAL INVESTIGATION

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Abstract

The article explores the impact of several health variables (both input and output) on India's economic growth. Cointegration and Error Correction econometric approaches were used on data from 1970 to 2010. Toda-Yamamoto causality test was used to determine the direction of causality between health condition and economic growth. The data imply that the impact of health is not only a long-term phenomenon, but also the short-term one showing significant effects. Growth has remained a risk factor for Health Status. Additionally, the data shows that the amount spent on public health has a little impact on GDP per capita.

Keywords: Health; Human capital; Per Capita GDP; Cointegration; Error Correction Model; Toda-Yamamoto Causality Test.

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In this Study, the terms 'Health' and 'Health Status' may be taken to have the same meaning, connotation and context and have therefore; been used interchangeably. The word 'Status' simply signifies the position/standing relative to that of the other variable(s).

1. INTRODUCTION

Human capital is nearly widely acknowledged as essential to the engine of economic progress. Sustained growth is dependent on human capital stocks increasing as a result of increased education, better health, and new and enhanced learning and training techniques. All the growth theories are in agreement to this. However, until "the second half" of the 1990s, growth economists devoted more attention to the analysis of the influence of education (human capital) on economic growth, while disregarding the function of health (human capital). Studies have just now started to examine health and attempt to "assess the relationship between health status and economic growth".

There is a symbiotic "relationship between health and economic progress". As one component of this relationship, good health is a crucial component of well-being. It's a natural assumption that excellent health increases human capital levels, and thus individual economic productivity and the country's economic growth rate. Good "health condition enhances workforce productivity by reducing incapacity, debility, the number of days lost to sick leave; and enhances the opportunities" an individual has of obtaining better paid work. Further, “good health helps to forge improved levels of education, by increasing levels of schooling and scholastic” performance. Another significant knock-on impact is the freeing up of resources for other purposes, such as mitigating the consequences of other negative externalities like community poverty, that would have been utilized for preventative health treatments. According to Fogel (1994), improvements in health resulted in approximately one-third of Britain's GDP in 1790-1980, “particularly improvements in nutrition, public health, and medical care facilities, and these improved health facilities should be considered labor-enhancing” technical changes. Economic growth, at the same time, results in “enhanced resources in terms of nutrition, better sanitation, and medical technology innovations, all of which improve the quality of life in terms of longer life expectancy, lower infant mortality rates, and better education”, among other benefits. According to the World Development Report 2007, the average life expectancy at birth worldwide has increased from 51 to 65 years in less than 40 years.

Following the pioneering papers by Mushkin (1962) and Newhouse (1977), a large number of empirical papers have attempted to investigate “health care spending and earnings” (e.g., Hansen and King, 1996; Clemente et al, 2004). These fundamental publications stated that health is a type of capital, and so health investment would be a significant source of income development. Furthermore, the “income elasticity should be positive” and bigger than unity (Gerdtham et al., 1992; Murray et al., 1994). Contrary to popular belief, existing research has failed to provide a clear picture of the income elasticity of demand for “health care, as well as the direction of causality between health care expenditure” and income. Retrospectively, a lot of empirical work has been done on this subject, though the scope and technique of investigations have varied greatly. Most of them have focused on developed countries by using the technique of panel data analysis (e.g., Roberts, 1999; Freeman, 2003; Gerdtham and Lothgren, 2000; Sen, 2005; Wang and Rettenmaier, 2007). But a country-specific study on developing countries such as India is relatively rare. Apparently, only a few studies {Arora, (2001) Bhargava *et al*., (2001) Chakraborty and Das, (2005), Rao et al. (2008)} have endeavoured to explore the “health status and economic growth” for India, using time series analysis; and have concluded that “health is an important determinant” of economic growth.

The aim of this paper is to investigate and analyze the “relationship between India's health and economic growth”. Long-term examination of health status and economic growth might be useful in understanding the potential magnitudes of health status's completely cumulative influence on economic growth. The causal relationship will be investigated to gain insight into the mechanism that drives the accumulation of health, human capital, and wealth.

It would be the endeavor of the researcher to make a meaningful contribution to the existing studies on “Health Status and Economic Growth”. This study would serve to enhance the existing literature in many ways like:

(1) Application of ARDL approach for cointegration was used to “determine the presence of a ‘long-run equilibrium’ relationship between Health Status and Real Income” in India. ARDL approach is a better cointegration strategy for small samples and may be applied without undue concerns about the order of variable integration.

(2) Formulation of an Index for Health Status Principal Component Analysis.

(3) Use of Toda-Yamamoto version of Granger Causality to determine causality between “Health Status and Economic Growth”. This test; too may be applied to all the series even if they are co-integrated.

(4) Bring into focus, the role of health status as an indicator. After “Structural Adjustment Programme” was implemented in 1991 by India, its impressive growth rate among South-Asian Countries has motivated many studies to determine various indicators of growth; but the role of health status as an indicator has not received adequate attention.

Rest of the paper has been organised as follows: Section 2 reviews theoretical framework; Section 3 reviews empirical literature; Section 4 talks about the status of “human capital situation” in India; Section 5 describes data and its sources; Section 6 gives a brief account of research techniques used; Section 7 discusses empirical results; and Section 8 concludes with policy implications and the last section lays down the limitation and defines the further scope of study.

2 THEORETICAL FORMULATION

An explicitly Neo-Classical framework includes accumulation of human as well physical capital; the Solow-Swan framework[1] is at the core of such Neo-Classical Growth models. In this framework; steady state Growth depends on technological progress and population Growth, both of which are exogenous to the model. In the "absence of technological progress", per capita output may not grow. Also, in this framework a rise in the Savings (Investment) rate can raise per capita economic growth in the short run. However, because of "diminishing returns to capital", per capita output in the long run grows at the rate of exogenously given technological progress.

Mankiw et al. (1992) "enhanced the aggregate production function" with human capital, for which educational attainment was employed as a proxy, and this was followed by many other augmented models. Human capital, according to Romer (1990) and Barro (1991), is possibly the most essential component in determining economic progress.

As the purpose of this paper is to investigate the effects of "human capital on economic growth" in terms of health. Human capital has been divided into two categories: health human capital (H) and other kinds of human capital, (e.g. education human capital (E)). Per capita income (Y) is believed to be a function of "physical capital (K), human capital (H), education human capital (E), and a vector of other variables (Z), which includes' technology and other environmental' variables".

$$Y=f\,(K,H,E,Z).. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where "Y is per capita GDP, H is health human capital, E stands is education human capital, and Z is meant for all other explanatory factors". H in "time t is the sum of the preceding period's stock of health human capital" and its addition to the present period's stock. It has been "assumed that the amount of resources spent to health care and the efficiency with which this expenditure" is translated into health stock (H) determine the buildup of health human capital stock (H). It has also been "assumed that the amount of resources committed to health investment is a function of the proportion of income devoted to health care (*Yh*)" and income level. The stock of "health human capital changes throughout time in the following" way:

$$H_t=H_{t-1}+\Delta H_t, \text{ and } \Delta H=\lambda\, Y_h\, Y, \quad . \quad . \quad . \quad . \quad (2)$$

Where λ is the "productivity parameter of health expenditure and all" other variables. The "ability to transform health expenditure into health stock has been assumed to be dependent on the stock of health human capital". The "health technology equation" can be written as : $\lambda=\lambda$ (H). Substituting λ into the ΔH equation, and that in "turn into the production function, the income" equation become:

In the present paper, the basic Solow model has been augmented to incorporate health as human capital following Barro, Mankiw et. Al.

$$\dot{Y}=\dot{Y}\,(\Delta K+\Delta E+\Delta H+H_{t-1}+Z) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The "per capita output equation that is estimated and the empirical model tested in the paper may be written" in the following form:

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[1] See Solow (1956) and Swan (1956). Recent application of the neoclassical growth framework include the papers by Khan and Kumar (1993), Knight and others (1993), and Mankiw and others (1992), Edwin Dewan and Shajehan Hussein (2001), Hoover, K. and S. Perez, (2004), Bassanini, A. and S. Scarpetta (2004), Romain Duval*, Christine de la Maisonneuve (2009).

$$LY_t = \alpha_0 + \alpha_1 AD_t + \alpha_2 LE_t + \alpha_3 IMR_t + \alpha_4 FR_t + \alpha_5 HB_t + \alpha_6 P_t + \alpha_7 SSE_t + \alpha_8 TR_t + \alpha_9 I_t + \varepsilon_t \quad ..(4)$$

Where "Y is real per capita GDP; age dependency" is represented by AD; expectancy is represented by LE; "Infant Mortality rate" is IMR; "Fertility Rate" is denoted by FR; hospital beds per 1000 of population is HB and Physician per 1000 of population is represented as P; "secondary school enrollment ratios" are represented by SSE; openness i.e. trade "as a percentage of GDP" is represented as TR and I is the gross capital formation representing physical capital.

3 EMPIRICAL REVIEW

According to empirical research there is a positive relationship between good health status and high national GDP. Higher incomes support better health by "increasing access to safe water and sanitation, as well as the opportunity to purchase more and better quality health care". Nonetheless, health may be both a cause and result of high income. This could be accomplished through a variety of processes (Bloom and Canning, 2000): (1) directly, through the "relationship between health status and individual incomes", (2) indirectly, through the "effect of health on levels of education", and (3) physically through capital investments.

Better "health status increases individual income significantly by increasing labor productivity, the number of hours worked, and labor force participation". This argument is embedded in nutrition-based efficiency wage theoretical models. For example, Leibenstein (1957) stated that those who ingested more calories than poorly nourished workers were more productive, and that improved nutrition is connected with gradually higher output. Workers that are healthier and more productive earn greater compensation (Strauss and Thomas, 1998). Higher salaries, in turn, contribute to higher levels of consumption and savings, which, by boosting people's well-being and happiness, contribute to economic growth and hence to a nation's social well-being (Luft 1978; Kassouf 1999; Arora 2001; Alves and Andrade 2003; Lorentzen et al 2005; Malik 2005; Tallinn 2006; Rao et al. 2008; Samudram et al. 2009; Tang 2009, 2010)

The second mechanism is predicated on the correlation between educational attainment and health. The state of a person's health has an immediate impact on their ability to learn and attend school (Cutler 2006; Sachs 2001; Bloom et al. 2004). Over time, this enhances a country's human capital and, consequently, its economic growth. The "depreciation rate of human capital stock is directly tied to the population's health state and both are higher or lower" depending on the technical level. Due to the inability to offset the costs, education investment is typically lower in nations with higher rates of depreciation (such as those with higher mortality rates or shorter life expectancies) (Falco and Soares 2005; Cutler D.M. and Lreras-Muney,A. 2006). Individually, bad "health status reduces educational returns" and thus influences family educational expenditures.

Higher mortality and fertility rates effect education, and hence on a nation's ability to produce wealth and boost economic growth (Sachs 2001; Lorentzen et al 2008; Tallinn 2006). Families with greater "infant mortality rates have higher fertility rates to compensate for the loss of previous" offspring. In general, risk aversion causes fertility rates to exceed mortality rates, therefore leaving less resources available for parents to devote to education. The links between "health, education, and economic growth" may be strengthened further by connecting them to technical progress; lower is the degree of human capital, the less amount of money is spent on research (Howitt 2005). Technology and technology advances are critical components of economic progress (Grossman and Helpman 1994).

A third factor linking "health to economic growth is the effect of health on physical capital investments". This pathway could operate via the savings rate or via "health externalities, also known as diffuse externalities", because individual health levels are also affected by a society's average health conditions (Sachs 2001; Scheffler 2004). This is true of "contagious diseases, including those which can be avoided with basic treatments. Such "externalities reduce investment levels", with the effect being especially pronounced in “less developed countries where health and poverty” are inextricably linked. African countries with high AIDS prevalence are instances of how health externalities can stymie economic growth. Among other things, corporate investments are particularly expensive in these nations, “partially because high rates of disease” increase both labor turnover and absenteeism, both of which raise training expenses (Sachs 2001).

4. HEALTH STATUS IN INDIA : THE EMERGING SCENARIO

India; with more than a billion population exhibiting wide economic and social diversities with respect to caste, culture, religion, and governance patterns has made considerable progress in health attainments and building up health infrastructure and manpower in government, voluntary and private sectors for primary, secondary and tertiary care, but much remains to be accomplished. The current state of the health sector infrastructure in India has been shaped by many policy prescriptions and programmes adopted from time to time, constitutional commitments, changing socio-economic perspectives and the emerging global health challenges. The major contributors in this regards has come from Bhore Committee (1946), Five Year Plans, “National Health Policies” announced in 1993, 2002, Population and Family Planning Programmes etc.

In the federal economic setup of India, health is a state subject; but health sector is jointly managed by the centre as well as states. Public spending (i.e. expenditures incurred by health departments of Central and State Governments) on health gradually accelerated from 0.22 per cent in 1950-51 to 1.05 per cent during the mid-1980s, and stagnated at around 0.9per cent of the GDP up to 2004-05. It increased thereafter to 1.37 in 2008-09. As percentage of GDP, Public sector health expenditures of all combined governments have declined from 1.25 in 1985-86 to 1.05 in 1995-96 and increased thereafter to reach about 1.2 per cent in 2006-07 (Table 1).

Table No. 1

PUBLIC EXPENDITURE ON HEALTH BY THE GENERAL GOVERNMENT : SOME RATIOS

S.N.	Variable	1974-75	1980-81	1990-91	2000-01	2008-09
1	As %age of total public expend	4.19	4.57	4.30	4.42	4.41
2	As %age of GDP	0.80	1.13	1.15	1.18	1.37

Source: Government of India, Indian Economic Survey, different years. WDI 2011.

The Indian healthcare spending is much less in contrast to its other important Southeast Asian countries like China and Sri-Lanka is far less. India spends only one-third on “preventive and curative healthcare”, whereas this proportion is as high as two thirds in China and Sri Lanka. Further, nearly three fourths, out of the total curative care spending is done on secondary and tertiary hospitals - primarily located in urban areas. Given that 70 percent of population resides in rural areas; the government spends too little on the day-to-day healthcare needs of the rural India. The administration must give this serious thought. Not only are health expenditures low, but so is the “delivery of available healthcare” facilities. Furthermore, “primary healthcare and rural health services have been overlooked” in favor of hospitals, medical colleges, and curative treatments in urban regions.

Table 2 lists some of the important "health indicators in terms of both input and output" to highlight health status in India.

Table No. 2

SOME HEALTH INDICATORS

S.N.	**INDICATORS**	**1951**	**1970**	**1980**	**1990**	**2000**	**2009**
1	Infant Mortality Rate (per 1000 live births)	146	137	110	80	68	45
2	Life Expectancy at birth, total (in years)	32	49.57	54.18	59.13	62.92	64.05
3	Life Expectancy at birth, Male	37	49.50	55.20	57.96	60.31	62.56
4	Life Expectancy at birth, Female	36	48.12	55.05	58.48	62.32	65.62
5	Birth Rate (per 1000)	41	41.10	34.43	30.20	25.80	22.45
6	Death Rate (per 1000)	25.1	17.60	12.90	9.70	8.50	7.30
7	Registered Medical Practitioners (RMP) per thousand population	_	0.20	0.37	0.46	0.55	0.60
8	Beds (Private + Public) per thousand population	_	0.60	0.77	0.79	0.73	0.90

Source: Economic Survey of India and WDI 2011

The above table shows that there has been improvement in most of the variables but the pace has been relatively slow. Infant mortality rate has improved from 146 in 1951 to 45 in 2009. As against these health status records, the life expectancy (LE) in India has not improved as remarkably as the other performance indicators. For instance, it was 54 years in the early 1980s, which increased to 66 years by the late 1990s. The overall rate of increase is 1.16 percent. The persistence of the relatively high crude birth rate calls for some more promotional and preventive health care measures in the future. Availability and accessibility of hospitals and doctors has not improved much; even after 64 years of independence. Health status in our neighboring countries like China and Sri-Lanka is much better than India[2] indicating the need to take a serious re-look at policies and focus on inputs in the health sector.

5. DATA SOURCES, PERIOD OF STUDY AND VARIABLES

The study spans 40 years, from 1970 to 2011. Table 3 has a brief summary of "the variables used" in this study. Health indicators are divided into two categories : input and output indicators. While "health input indicators include health care expenditure, availability and quality of health facilities", and so on, "health output indicators include life expectancy, infant mortality rate, adult survival rate, fertility rate", and so on.

[2] Asian Development Bank 2011 & WDI 2011.

Table No. 3

VARIABLES, SYMBOLS AND DATA SOURCES

S.N.	VARIABLES	SYMBOLS	DATA SOURCES
1	Per Capita GDP (proxy for economic growth)	**Y**	WDI 2011
2	Age Dependency	**AD**	WDI 2011
3	Birth Rate Crude per 1000 of Pop.	**BR**	WDI 2011
4	Death Rate Crude per 1000 of Pop.	**DR**	WDI 2011
5	Life expectancy	**LE**	WDI 2011
6	Infant Mortality Rate	**IMR**	WDI 2011
7	Fertility Rate	**FR**	WDI 2011
8	Health Expenditure % of GDP	**H**	WDI 2011, Country Sources
9	Beds (Private + Public) per thousand population	**HB**	WDI 2011, Country Sources
10	Nurses per 1000 of Population	**N**	WDI 2011 Country Sources
11	Registered Medical Practitioners (RMP) per thousand population	**P**	WDI 2011 Country Sources
12	Secondary School Enrolment Ratios	**SSE**	WDI 2011, ADB Key Indicators 2011
13	Openness (Trade % of GDP)	**T**	WDI 2011
14	Investment % of GDP	**IC**	WDI 2011

The above-mentioned "health indicators were chosen for this investigation" based on current literature and the availability of time series data. Data used in the study was interpolated using Dig DB 7.1.3.3 and an Excel Add-in, as continuous time series data for chosen variables was not available.

Independent variable GDP Per Capita has been utilized as a proxy for "Economic Growth" in the model.

Health Status Index includes in total; nine variables i.e. AD, BR, DR, LE, IMR, FR, H, HB, N and P; as explained in table 3. The Index has been formulated on the basis of Principal component analysis and fairly represents Health Status in India.

6. RESEARCH TECHNIQUES

The econometric methodologies utilized in this paper are described in full below. Several econometric techniques are available for evaluating the cointegrating connection. However, due to its higher performance in small samples, the researcher decided to employ the Bounds Testing Approach (Pesaran et al., 2001) within the "Autoregressive Distributed Lag" (ARDL) framework. The advantages of this model are that it can be implemented regardless of whether the underlying explanatory variables are simply I(0), strictly I(1), or mutually co-integrated. A General-to-Specific Modelling Framework requires a sufficient number of lags to describe the data generation process. A "simple linear transformation can also be used to derive a Dynamic Error Correction Model" (ECM) from ARDL. The model has an advantage since the ECM integrates short-run dynamics with long-run equilibrium without sacrificing long-run information.

Amongst most of the methods for performing the cointegration test, the most popular used are the "**Residual Based Engle-Granger (1987) test"** and the "**Maximum Likelihood Test Johansen (1992; 1994) Johansen-Juselius (1990)".**[3] Due to low availability of "power and other problems associated with these methods, the OLS based Autoregressive Distributed Lag (ARDL) approach to cointegration" has gained popularity since the early 1990's. The ARDL model was initially introduced {by Chremeza and Deadman (1992) and was later popularised by Pesaran and Pesaran (1997), Pesaran and Smith (1998), Pesaran and Shin (1999), and Pesaran et al. (2001)}.

As an illustration for the ARDL modeling approach, in simplest manner may be considered as given by Equation (5):

$$y_t=\alpha+\beta x_t+\delta z_t+\varepsilon_t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (5)$$

where y_t, x_t and z_t are "three different time series"; e_t is a "vector of stochastic error terms"; and α and β are the" parameters".

For the above equation, the "Error Correction version of the ARDL model" may be given by the Equation (6):

$$\Delta y_t=\alpha_0+\sum_{i=1}^{p}\beta_i\Delta y_{t-i}+\sum_{i=1}^{p}\delta_i\Delta x_{t-i}+\sum_{i=1}^{p}\varepsilon_i\Delta z_{t-i}+\lambda_1 y_{t-1}+\lambda_2 x_{t-1}+\lambda_3 z_{t-1}+u_t$$

The first part of equation (6) with β, δ and ε represents the "short run dynamics of the model" whereas "the second part with λ_s represents the long run" relationship. The "null hypothesis in the equation is $\lambda_1=\lambda_2=\lambda_3$ which means the non-existence of the long run" relationship.

When there is a "long run relationship between variables, there exists an error correction representation". Therefore, estimation of the "long run relationship is followed by the estimation of the Error Correction Model". The "error correction model result" will indicate the "speed of adjustment back to the long run equilibrium" after a short run shock.

In the **"Causality Test,** the Direction of Causality between Health Status and Economic Growth" may be determined by using the "Granger Causality version of **Toda and Yamamoto Test (1995)".**

The "standard Granger (1969) causality test for inferring leads and lags among integrated variables may result in false regression findings, and the F-test is invalid unless the variables in levels" are co integrated. The Error Correction Model (developed by Engle and Granger (1987)) and the Vector Auto Regression Error-Correction Model (developed by Johansen and Jesulius, 1990) are new advances in econometrics that give methods for testing non-causality between economic time series. Unfortunately, these tests are time-consuming and sensitive to the nuisance parameter values in limited samples, making their conclusions inaccurate (see Toda and Yamamoto, 1995; Zapata and Rambaldi, 1997).

Toda and Yamamoto (1995) proposed "a simple procedure requiring the estimation of an 'Augmented' VAR, even when there may be cointegration, which guarantees the asymptotic distribution of the MWald statistic". Therefore, the "Toda-Yamamoto causality procedure has been labeled as the long-run causality test". All that is required to be done is to determine the "maximal order of integration d_{max}, which is expected to occur in the model and then construct a VAR in their levels with a total" of ($k + d_{max}$) lags. Toda and Yamamoto "point out that, for d=1, the lag selection procedure is always valid, at least asymptotically, since k > =1=d. If d=2, then the procedure is valid unless k=1". Moreover, according to" Toda and Yamamoto, the "M-Wald statistic is valid regardless whether a series is I (0), I (1) or I (2), non-co integrated

[3] These "methods require that all the variables in a model" should have equal degree of integration i.e. I(1).

or co integrated of an arbitrary order". In addition, the "MWALD test has a comparable performance in size and power" to the likelihood ratio (LR) and Wald tests[4].

In order to clarify the principle, consider the following example of a "bivariate model", with one lag (k=1). That is,

$$x_t = A_0 + A_1 x_{t-1} + e_t \qquad . \quad . \quad . \quad . \quad . \quad . \qquad (7)$$

Or more fully;

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(1)} & \alpha_{12}^{(1)} \\ \alpha_{21}^{(1)} & \alpha_{22}^{(1)} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \qquad . \quad . \quad . \qquad (8)$$

$$E(e_t) = E\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = 0 \qquad . \; . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (9)$$

And

$$\mathrm{E}(e_t e_t') = \Sigma \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (10)$$

To test that x_2 "does not Granger cause" x_1, the parameter restriction $\alpha_{12}^{(1)} = 0$ will be tested. If it is assumed that x_{1t} and x_{2t} are I (1), then a "standard t-test" is not valid. Following Dolado and Lutkepohl (1996), $\alpha_{12}^{(1)} = 0$ may be tested by "constructing the usual 'Wald test' based on least squares estimates" in the augmented model:

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(1)} & \alpha_{12}^{(1)} \\ \alpha_{21}^{(1)} & \alpha_{22}^{(1)} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(2)} & \alpha_{12}^{(2)} \\ \alpha_{21}^{(2)} & \alpha_{22}^{(2)} \end{bmatrix} \begin{bmatrix} x_{1,t-2} \\ x_{2,t-2} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \qquad (11)$$

The "Wald statistic will be asymptotically distributed as a Chi Square, with degrees of freedom equal to the number of zero restrictions", irrespective of whether x_{1t} and x_{2t} are I (0), I (1) or I (2), "non-cointegrated or co integrated" of an arbitrary order.

Employing seemingly unrelated regression framework (SURE), the researcher has estimated VAR(2). Following "TY non-causality test in this study, these variables" can be causally linked in a system as follows:

$$\begin{bmatrix} Y_t \\ HS_t \end{bmatrix} = \beta_0 + \beta_1 \begin{bmatrix} Y_{t-1} \\ HS_{t-1} \end{bmatrix} + \beta_2 \begin{bmatrix} Y_{t-2} \\ HS_{t-3} \end{bmatrix} + \beta_3 \begin{bmatrix} Y_{t-3} \\ HS_{t-3} \end{bmatrix} + \begin{bmatrix} eY_t \\ eHS_t \end{bmatrix} \quad .. \qquad (12)$$

In the above equation; Y is income (GDP per capita) and HS is Health Status represented by Health Status Index.

Principal Component Analysis (PCA) has been used to formulate Health Status Index. It is a technique for simplifying a data set by reducing multidimensional data sets to lower dimensions for analysis. Technically speaking, PCA is "an Orthogonal Linear Transformation that transforms the data to a new coordinate system so that the greatest variance by any projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance on the second coordinate", and so on. PCA can be used for "dimensionality reduction in a data set while retaining those characteristics of the data set that contribute most to its variance, by keeping lower-order principal components and ignoring higher-order" ones. Such

[4] Zapata and Rambaldi, (1997)

low-order components often contain; the "most important" aspects of the data.The methodology of "Principal Component Analysis" has been discussed in detail by Theil (1971)[5].

Unit Root Test: As the first step in time series econometrics; the researcher has applied unit root test[6] to check the order of integration. There are plenty of unit root tests available; each having their "own set of advantages and disadvantages" *but in the present paper; the researcher has applied the "Augmented Dicky Fuller (ADF) and the Philip-Perron (PP)" unit root tests*. "Unit Root tests are conducted to verify the stationarity properties" (absence of trend and long- run mean reversion) in the time series data so as to avoid spurious regressions. A "series is said to be (weakly or covariance) stationary if the mean and autocovariances of the series" do not depend on time. A series is said to be "integrated of order d, denoted by I(d)", if it has to be differenced d times before it becomes stationary. Consider the equation:

$$\gamma_t=\rho\gamma_{t-1}+\chi_t\delta+\varepsilon_t \quad . \quad . \quad . \quad . \quad . \quad . \qquad (13)$$

Where χ_t are optional "exogenous regressors which may consists of constant, or a constant and trend, ρ and δ are parameters to be estimated, and ε_t is assumed to be white noise". If $|\rho| \geq 1$, γ is a "nonstationary series and the variance of γ increases with time and approaches infinity if $|\rho|<1$, γ is a (trend) stationary" series. Thus, the "hypothesis of (trend) stationarity can be evaluated" by testing whether the absolute value of ρ is strictly less than one.

ADF test using MacKinnon (MacKinnon, 1991) critical values, constructs a parametric correction for higher-order correlation by assuming that the y series follows an AR (p) process and adding p lagged difference terms of the dependent variable y to the right-hand side of the test regression.

$$\Delta\gamma_t=\alpha\gamma_{t-1}+\chi_t\delta+\beta_1\Delta\gamma_{t-1}+\beta_2\Delta\gamma_{t-2}+....+\beta_2\Delta\gamma_{t-2}+v_t \qquad (14)$$

This augmented specification is then used to test the hypothesis:

$$H_0:\alpha=0, \text{ against } H_1:\alpha<0 \qquad (15)$$

If the "null hypothesis $H_0:\alpha=0$ is" not rejected, it implies that $\alpha=0$ and the series $\boldsymbol{\alpha}$ contains a unit root. Where $\alpha = \rho - 1$ and evaluated using the conventional t-ratio for $\boldsymbol{\alpha}$

$$t_\alpha = \hat{\alpha} / (se(\hat{\alpha})) \qquad (16)$$

Where $\hat{\alpha}$ is the estimate of α and *se* $(\hat{\alpha})$ is the coefficient standard error.

Phillips (1987) and Phillips-Perron (1988) have suggested an alternative approach for checking the "presence of unit roots" in the data. They have "formulated a nonparametric test to the conventional t-test" which is "robust" for a wide variety of serial correlation and time dependent hetroscedasticity. The PP unit root test requires to estimate the following equation (without trend).

7. EMPIRICAL RESULTS

$$X_t=\mu_t+\sum_{i=1}^{t} X_{i-T} + u_t \qquad (17)$$

The "ARDL (Auto Regressive Distributive Lag) Model could have been used directly, however as is common in time series econometrics, first unit root test was

[5] Theil (1971)

[6] For a detailed discussion on unit root test please refer to text book on time series econometrics.

performed, and the results" are shown in table 4. Majority of the chosen variables have a "unit root at level" and are stationary at "first difference except" Age Dependency ratio which is I(0) at level with trend and a lag in DF test but not in PP test.

Table no. 4

UNIT ROOT TEST

Variables	With A Constant		With A Constant And Trend		First Difference With A Constant	
	ADF	PP	ADF	PP	ADF	PP
LY	3.913	4.904	-0.964	-0.822	-5.095*	-5.165*
AD	13.720	7.663	-3.594*(1)	2.490	1.472	0.510
LE	-1.267	-1.785	-1.438	-0.992	-10.900*	-10.495*
IMR	-0.772	-0.726	-2.863	-2.893	-9.869*	-9.871*
FR	-0.818	-0.764	-2.772	-2.890	-6.343*	-6.364*
H	0.747	0.378	-0.072	-0.334	-5.352*	-5.455*
HB	-0.270	-0.427	-1.284	-1.618	-6.490*	-6.538*
P	-0.365	-0.357	-3.085	-3.160	-8.059*	-8.099*
SSE	0.691	0.706	-2.351	-2.581	-6.169*	-6.173*
TR	0.464	0.566	-1.329	-1.345	-6.626*	-7.028*
I	-0.606	-0.322	-2.263	-2.253	-7.915*	-8.026*
HS	-0.457	-0.462	-2.082	-2.015	-7.540*	-7.567*
Critical Values	-2.961	-2.961	-3.544	-3.544	-2.964	-2.964

*Note: * indicates significance at 5% and above level.*

Source: Author's Calculation

The ARDL estimates $(p+\text{i})^k$ number of regressions; in order to obtain "optimal lag length for each variable, where p is the maximum number of lag to be used and k is the number of variables" in the equation. As the data used here is of annual frequency, 2 has been selected as "maximum lag" to be used; following Pesaran and Pesaran (1997). Maximum lag order in the "model is based on Akaike's Information Criteria (AIC)" as it chooses maximum relevant lag length. To ascertain the appropriateness of the model, diagnostic and stability test have been conducted.

To examine the impact of Health Status on Economic Growth; the following ARDL has been conducted (it is the equation no. 4, already referred to above, repeated however; for convenience):

$$LY_t = \alpha_0 + \alpha_1 AD_t + \alpha_2 LE_t + \alpha_3 IMR_t + \alpha_4 FR_t + \alpha_5 HB_t + \alpha_6 H_t + \alpha_7 SSE_t + \alpha_8 TR_t + \alpha_9 I_t + \varepsilon_t \,. \qquad (18)$$

Calculated F statistics for bound tests have shown that there exist at least "two co-integrating vectors[7] and there exits; a long run relationship between determinants of Health Status and Economic Growth". Table 5 presents final parsimonious result of "ARDL model in terms of long-run and short run" elasticity's along with diagnostic statistics and stability test.

[7] Result table is excluded due to paucity of space but is available from researcher.

Table no. 5

ARDL (1,1,2,0,0,0,2,0) MODEL BASED ON AIC LONG RUN RESULTS: DEPENDENT VARIABLE IS LY

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Constant	9.7459*	1.1103	8.7779[.000]
AD	-.036318*	.0078353	-4.6352[.000]
LE	.023070*	.0097171	2.3742[.026]
IMR	.0032957*	.0011513	2.8627[.009]
HB	.26979*	.11057	2.4400[.022]
SSE	.032858*	.0012732	2.5807[.016]
TR	-.0035548	.0019147	-1.8566[.076]
I	.0027296	.0028550	.95605[.349]

*Note: * indicates significance at 5% and above level.*

Source: Author's Calculation

Results in table 5 reveal that in the "long run age dependency negatively" affects per capita GDP, as more people "become idle" due to age or other factors; such people would definitely "have negative impact" on economic growth. Health expenditure failed to show any impact and was dropped from the equation. Nevertheless, "other health status indicators like life expectancy, mortality rate and population per bed" have all shown to have "small but significant impact" on economic growth. A "positive impact of population per bed" has shown that as population per bed reduces with growth of a nation; it contributes to the nation's growth i.e. better infrastructure health facilities will enhance Economic Growth. "Secondary education" remains highly significant; implying that "more educated are the nation's workers, greater will be their potential to catch up with prevailing technologies" and achieve the economic growth. The "gross capital formation has failed to show any significant impact on economic growth" in the long run, thereby contradicting the normally accepted theoretical principles; however, the relationship is shown to be positive. Table 6 presents "the results of the Error Correction Model of the ARDL (1, 1, 2, 0, 0, 0, 2, 0) version" discussed above. Result is depicted in the short run too; majority of the Health Status "determinants have a small but significant" impact on Economic Growth. Openness with a lag has shown "a positive and significant" impact on Growth. The "coefficient of ECM is statistically significant at 1 per cen"t level. This implies "that there is a strong error correction mechanism" and 83 percent of the deviation from long run equilibrium" previous year has been corrected in the current year after a short-run shock, indicating a "very high speed" of adjustment.

Table No. 6

ARDL (1, 1, 2, 0, 0, 0, 2, 0) MODEL ECM RESULTS: DEPENDENT VARIABLE IS ∆LY

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dINPT	8.0954	1.7464	4.6356[.000]
dAD	-.27429	.072316	-3.7929[.001]
dLE	.013717	.010348	1.3257[.196]
dLE1	.017334	.010224	1.6954[.102]
dIMR	.0027376	.8689E-3	3.1507[.004]
dHB	.22410	.10087	2.2218[.035]
dSSE	.0027293	.9904E-3	2.7559[.010]
dTR	-.0027943	.0026575	-1.0515[.302]

dTR1	.0045894	.0022595	2.0311[.052]
dI	.0022673	.0024164	.93830[.356]
ecm(-1)	-.83065	.13193	-6.2960[.00]

*Note: * indicates significance at 5% and above level.*

Source: Author's Calculation

Table 7 presents the key regression statistics, diagnostic and stability tests for the above discussed model. The high value of R^2 shows that overall goodness of fit for this model is extremely high. The F statistics measuring the joint significance of all regressors in the model are "statistically significant" at 1 per cent level. Durbin-Watson statistics is also close to two.

Table No. 7

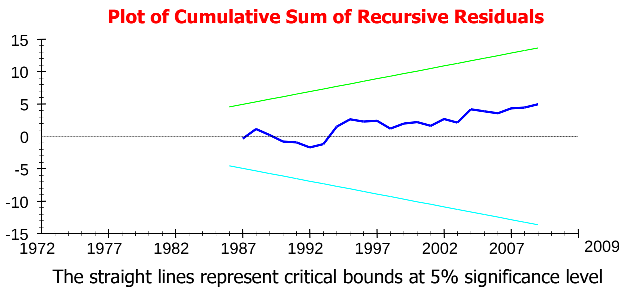
Key Regression Statistics	
R-Squared	.99899
R-Bar-Squared	.99845
F-stat. F(13, 24)	1833.7[.000]
Durbin's h-statistic	-.27071[.787]

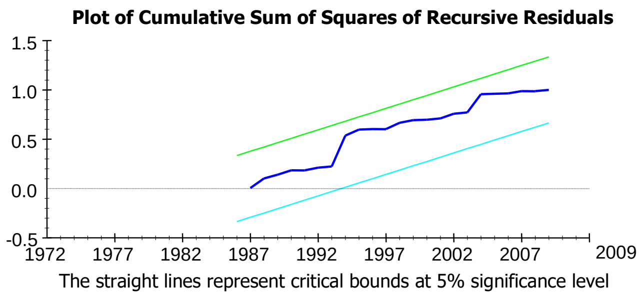
Diagnostic Test Result	
Serial Correlation	F(1, 23)= .035896[.851]
Functional	F(1, 23)= .30244[.588]
Normality	CHSQ(2)= 2.2004[.333]
Heteroscedasticity	F(1, 36)= 1.6464[.208]

Source: Author's Calculation

As per the diagnostic statistics, the model passed all of the tests. The plots of CUSUM and CUSUM of statistics in Figure 1 show that the estimated parameters remain steady across the analysis period, despite the caveat of analysis.

Figure 1





The results reveal that in the "long-run as well as short-run" indicators of human capital i.e. health and education; have both shown to have significant impact on economic growth. Conclusions are in line with Akram Naeem (2009); Pradhan, Mnish Kumar and Sanyal (2011) but different from Garima Malik(2006). On the basis of the results obtained in this study, it may be said that for sustainable economic growth; policies should be aimed for improving the standards of Health and Education in India.

The presence of a long-run association did not establish a causal direction, but it did confirm that testing for causality is significant and not just a prediction test. The policy implications of the causality between Health Status and Economic Growth are significant. Table 8 shows the Toda-Yamamoto test results for causality.

From the causality results, it was found that the "null hypothesis of Economic Growth does not Granger-causes" Health Status, the *p*-value for the "MWALD test statistic is less than 0.10". This shows that the null hypothesis may be rejected and Granger-causality is running from Economic Growth to Health Status in India. The findings of this paper suggest that "there is Unilateral Causality running" from Growth to Health Status; rather than other way round. The result is in line with Pradhan, Mnish Kumar and Sanyal (2011).

Table No 8

HEALTH STATUS VS GROWTH
LONG RUN CAUSALITY DUE TO TODA-YAMAMOTO TEST BASED ON SUR ESTIMATION

Null Hypothesis	Mwald Statics With P Values
Health Status Vs Growth	
Health Status does not granger cause Growth	0.54122[.462]
Growth does not granger causes health Status	5.4911*[.019]

*Note: * indicates significance at 5% and above level. p-values of MWALD statistics are given in parentheses.*
Source: Author's Calculation

8. CONCLUSIONS AND IMPLICATIONS FOR POLICY

The basic premises of this research is to analyze both "short and long run effects of health status on economic growth"; to test the "direction of causality" between "Health Status and Economic Growth". To attain these objectives; ARDL based cointegration approach of Pesaran and Pesaran (1997) and "Toda-Yamamoto version of Granger causality" have been used.

The findings show "that age dependency, population per bed, secondary school enrollment, life expectancy, and mortality rate have an impact on Economic Growth" as measured by Real Per Capita GDP; physical capital, openness, health expenditure, and physician per thousand population have an insignificant impact on

Growth. The findings confirm that health variables play a little but important impact in predicting both long-run and short-run economic growth.
As examined by the bound test in the ARDL technique, “health status and economic growth” were shown to be co-integrated, indicating a long run link between the two. After all is said and done, it lacks any direction of causality, which is critical for any national policy choice. The Toda-Yamamoto version of “Granger causality confirms the existence of unidirectional causality in India from Economic Growth to Health Status”.

The above results may be said to have important policy implications; although health input and output variables have “significant impact on economic growth” yet it is Growth which remained the casual factor of Health Status. In short, India needs to focus on “policies related with Growth as it has been shown to be the driving force for Health Status” and it is not the other way round; supporting the ‘trickle down’ theory advocated by the policy makers at the time of independence. However, it is necessary to point out that Economic Growth, *per se, on its own;* is necessary but may not be sufficient to guarantee improvements in “Health Status” and thus the resources generated by economic Growth need to be specifically channelized and directed towards Health human capital, leading “ultimately to the welfare and social development” of a nation. This also implies that “Governments” need not be compelled to accept the ‘diktat’ to withdraw subsidies being given to fulfill the basic health needs of the underprivileged, as often advocated by the proponents of the Structural Adjustment Programme (SAP) and instead need to adopt a gradualist approach to SAP policies in the Health Sector.

9. LIMITATIONS AND SCOPE FOR FURTHER RESEARCH:

Despite the “fact that this paper may have been the first” to use a time series spanning 40 years, a major weakness of this paper may be the amount and selection of variables employed as a proxy for Health Status. The paper also defines the further scope for research, which should be to confirm the result obtained here under through application of a wider and bigger set of variables as proxy for Health Status in India. An index for health input and output can be developed, and its relationship to growth can be investigated further.

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