HEALTH INPUTS, HEALTH OUTCOMES AND ECONOMIC PERFORMANCE: EVIDENCE FROM THE INDIAN STATES

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DEBOSREE BANERJEE

Centre for International Trade and Development
School of International Studies
JAWAHARLAL NEHRU UNIVERSITY
New Delhi 110067
INDIA
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CENTRE FOR INTERNATIONAL TRADE & DEVELOPMENT
SCHOOL OF INTERNATIONAL STUDIES
JAWAHARLAL NEHRU UNIVERSITY
NEW DELHI - 110 067

Tel : 011-2670 4338
Fax : 91-011-2671 7586
Gram : JAYENU

Date: 20.07.07

DECLARATION

I declare that the thesis entitled "Health Inputs, Health Outcomes and Economic Performance: Evidence from the Indian States" submitted by me for the award of the degree of **Master of Philosophy** of Jawaharlal Nehru University is my own work. The thesis has not been submitted for any other degree of this University or any other university.

Debosree Banerjee

DEBOSREE BANERJEE

CERTIFICATE

We recommend that this thesis be placed before the examiners for evaluation.

Prof. Amit Shovon Ray
Chairperson,
Centre for International Trade and Development

Chairperson
Centre for International Trade & Development
School of International Studies
Jawaharlal Nehru University
New Delhi-110067

Prof. Amit Shovon Ray
Supervisor

Professor
Centre for International Trade & Development
School of International Studies
Jawaharlal Nehru University
New Delhi-110067

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Debosree Banerjee

Debosree Banerjee

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Chapter 1: Introduction

Health economics is an applied field of economics. It draws its theoretical inspiration principally from the following traditional areas of Economics: microeconomics and industrial organization, development and growth theory, public finance. By almost any criterion, health economics has been a remarkably successful sub-discipline of economics that has significantly contributed to several issues in mainstream economics - the theory of human capital, the economics of insurance, agency problem, problems of asymmetric information, theories of incomplete/missing markets etc.

1.1 Health as a Commodity: Nature and Characteristics

At the outset, we must understand the peculiar nature of "health" as a commodity. Health is not like any other economic good. It is neither a pure private good nor a pure public good. To a certain extent, it is excludable – the introduction of user fees for health care services for instance could potentially exclude a large segment of the population who can not afford to pay. Like wise, there may some degree of rivalry in consumption of some dimensions of health care (e.g., medications, vaccines, hospital beds, doctor's time etc.).

But, the market for health care is slightly different from that of a private good. Health as a commodity shares certain features – externality, asymmetric information, uncertainty, induced demand for instance – which lead to incidence of market failure. ***Externalities*** in health care may arise for different reasons. For example, different immunization programmes like polio immunization etc can cerate positive externality, whereas negative externality may arise in case of different communicable diseases. However, presence of externalities for health leads to a divergence between private and social marginal costs of health care, leading to market failure.

Secondly, market for health care is characterised by different sorts of ***uncertainties*** (Arrow, 1963) – uncertainty regarding price and quantity of medical care, efficacy of medical interventions etc.

These uncertainties often arise because of lack of information or ***asymmetric information***. Consumers/patients greatly rely on their physicians for their health related decision making. Physicians are supposed to be 'perfect agents' of the consumers (Phelps, 1992). They recommend them about treatment, different health related measures etc which the patients should follow. However, physicians are sometimes accused of inducing demand in the health care market for their own profit motives. This creates an artificial demand or supplier ***induced demand*** in the health market. This demand need not reflect the "true" demand in the market for health.

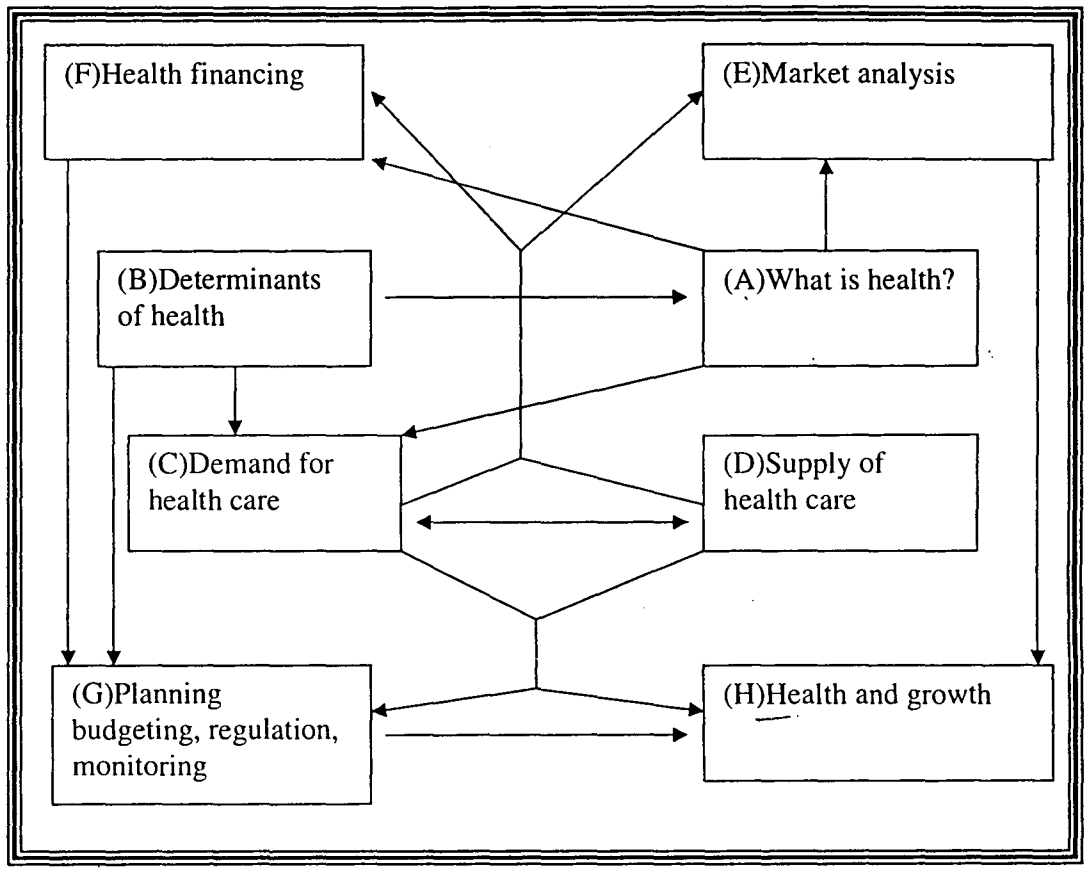
All these problems together contribute to ***market failure in health care***. One could best characterise health as a "merit good" which calls for judicious government intervention in its market-driven resource allocation.[1]

1.2 Scope of Health Economics

To describe the scope of health economics, Williams (1987) introduced, for the first time, a schematic diagram that has been reproduced with some editing by Culyer and Newhouse (2000) in the Handbook of Health Economics. We present a slightly modified version of the same below to understand the scope of health economics – the issues and topics covered and the logical links between them.

[1] A merit good is defined in economics as a good that is under consumed if provided by the market mechanism because of positive externalities that are not internalized by consumers. To increase efficiency, the state may choose to encourage greater production or consumption of a merit good through state provision, regulation, subsidies or to produce the good itself.

Figure 1.1: Scope of Health Economics: A Schematic Diagram



Box A explains the conceptual foundation of health. It contains multi disciplinary literature with contributions from economists, epidemiologists, operational researchers and others. The central issue of this box is to understand the meaning of health and its relationship with welfare.

Box B deals with the determinants of health – genetic, environmental, social, economic and behavioral. Health is viewed as human capital not just in the sense of a stream of discounted returns over the expected lifetime, but also in the sense that it is a capital stock that can be invested in, which depreciates over time and its demand is influenced by the other component of human investment like education.

Box C concerns the demand for healthcare. It is a derived demand (from the demand for health). Here the issues of utility interdependency (externality), where

a tension between need and demand are addressed and questions regarding revealed demand have been also discussed.

Box D explains the supply side of health care: hospital production function, input substitutions, behavioral relations, industrial regulations, response of the institution and health workers to change in their environment and mode of payment etc. Health care industry encompasses not only the obvious health care organizations but also the public and private caring agencies that deal with particular groups, like, the elderly, mentally infirm, disabled etc.

Box E deals with the way in which the markets in all these sectors operate. This constitutes a major chunk of applied health economics.

Box F is specifically evaluative and normative. It explains cost effectiveness and cost utility, cost benefit analysis of alternatives way of delivering health care. However, in health care, cost is shared by the consumers and insurance companies. There could be three types of cost sharing – (1) purely demand side cost sharing where the consumer is paying the entire amount leading to problem of induced demand, (2) purely supply side cost sharing where the consumer is fully insured creating moral hazard problems and (3) co-payment system where certain percentage of the cost will be borne by insurance providers and the rest will be paid by the consumers. Co-payment system brings efficiency and fairness in the health care delivery process.

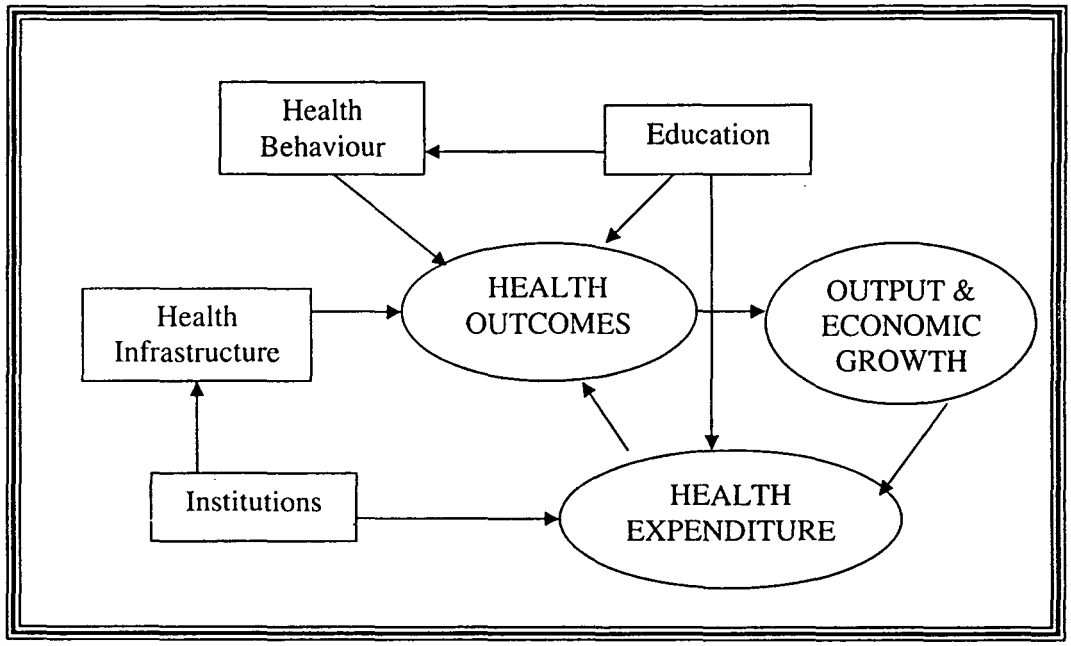
Box G discusses the issue of budgeting, regulating, planning and the monitoring of the health care system. It evaluates the effectiveness of instruments available for optimizing the system in terms of equity and efficiency. However, we can always find a trade-off between equity and efficiency in this context.

Box H concerns health and economic growth. There is a vast theoretical as well as empirical literature focusing on health as a determinant of economic growth, impact of economic growth on health and issues of inequality and health. The large and growing body of economics literature on this theme indicates a strong positive relationship between health and economic growth/ prosperity.

1.3 Objective of the Thesis

In this thesis, our focus is primarily on the theme of Box H, namely the contribution of health in economic performance. From the theoretical and empirical literature, it is absolutely clear that, apart from labour and physical capital, health also acts as an important input into aggregate output levels through increase in productivity. This is the basis of the Sachs prescription for developing countries to invest a significant portion of their resources in the health sector. However, investment in health does not automatically ensure increased output levels. Health inputs must be translated into health outcomes efficiently, which in turn raises productivity and output levels. So we must have a comprehensive idea about the so-called "***health production function***", that maps health inputs to health outcomes, which in turn contributes to economic growth. The complex set of forces at play can be glanced from the following schematic diagram:

Figure 1.2: Health and Economic Growth – A Schematic Framework



However, most of the empirical literatures have only associated health status (life expectancy, infant mortality rate etc) or health determinants (health investment, education etc) separately with economic performance. But following Schultz (2004) we can say 'health itself is viewed as current service derived from depreciating stock of human capital, formed by investment in medical care and

also impacted by health related behaviors such as smoking which interacts with individuals health stock'. Therefore, health status is not something, which is given exogenously. Current health status may well be influenced by certain attributes. Therefore, we need to have a comprehensive idea of this complicated relationship described in the schematic diagram of fig 1.2.

The schematic diagram helps us to understand that health status and health determinants do not function separately. On the contrary, conditions of the health status may well be influenced by different health determinants like health expenditure, infrastructure, education etc. and some of these determinants also interact among each other. For example education influences health behavior by creating awareness, health allocation and proper functioning of health infrastructure is governed by institutional structure of the nation etc. Therefore, in this context that we can conceptualize a ***health production function*** which is essentially a mapping from health inputs to health outcome or health status through a complex interplay of several factors depicted in the diagram.

From this conceptualization of the health production function, it is evident that that even if investment is made in the health sector and resources are allocated, good health status of the citizens need not always be achieved. The issue of health status and resources involves great degree of functional and institutional strategy efficiency. Unless efficiency is achieved in the whole process of transferring theses health inputs to health outputs, achievement of good health status will remain a myth.

In this thesis, our objective is to examine the role of health in economic performance in the context of India, following this comprehensive structure. Effectively then, the focus of our thesis will fall under the themes of Box H as well as Box B – analysing the determinants of health outcomes (a health production function) and estimating the role of health in India's economic performance.

In 1991, India initiated its economic reform, whose objective was to initiate a decisive break away from the strongly inward-oriented trade policy regime,

thereby providing an environment for efficient industrialisation and better export performance. Recognising the importance of the international competitiveness in an increasingly interdependent world, liberalising the economy was crucial, because the high-cost –low–quality structure of the Indian industries had brought about a steady long-term decline in the India's share of world trade from 2% in 1950 to 0.5% in 1990 (Ahluwalia and Little, 1998).

While India's new economic policy regime (focusing primarily on trade and industries) has been quite successful in creating a conducive environment for faster rate of growth especially driven by the manufacturing and the services sectors, it has sometimes been alleged that there has not been adequate policy attention towards the social sectors and a quest for inclusive growth. Dreze and Sen (1995) argued that the success of liberalisation and closer integration with the world economy may be severely impaired by India's backwardness in social sectors like basic education, health care etc. It is therefore important to research on the role of the social sectors in India's economic performance. In our study we will focus on the health sector of India and attempt to examine the complex relationships between health allocations (or health inputs), health outcomes and economic performance at the macro level.

At the macro level very little work have been done on the issue of health and economic growth in India. The two studies, focusing on this specific theme, are Mahal (2005) and Gupta and Mitra (2003). Both studies attempted to examine the role of health in India's economic growth using state level data. But neither has adopted the comprehensive framework as discussed above. In this thesis, we intend to adopt this framework for a more rigorous understanding of the complex interplay of health inputs, health outcomes and economic performance from Indian state level evidence.

1.4 Research Questions and Chapters of the Thesis

As discussed above, the thesis addresses two broad research issues:

a. Estimation of a health production function for India

b. Analysis of the contribution of health to India's economic performance.

These issues will be addressed on the basis of Indian state level secondary data using models and tools of applied econometrics.

The thesis has five chapters. After this introduction, chapter 2 presents a review of the theoretical and empirical literature pertaining to the research issues addressed in this thesis. Chapter 3 presents the estimation of health production function. Chapter 4 presents an econometric analysis of the role of health in economic performance. Chapter 5 concludes.

Chapter 2: A Review of Literature

Health economics is essentially an applied field of Economics covering a wide range of activities. In this section we have tried to present a thematic review of the literature on health and economic growth. However these themes do not cover all the aspects of Health Economics. We have mainly concentrated on issues that are related to our study, i.e. health and economic growth.

We begin with a brief review of the theories of economic growth, focusing especially on endogenous growth models that highlight the role of human capital in economic growth. We also discuss the literature that considers 'health' as a key component of human capital.

Next, we consider the literature on health and economic growth which helps us to understand the impact of health on economic growth and the reverse causal link, i.e., the impact of economic performance on health status of citizens.

Then, we present a review of the literature on the determinants of health. Here we identify both macro and micro level determinants and discuss the effects of different exogenous and endogenous factors that have considerable influence on health status.

Finally, we consider a brief review of literature regarding health production function.

2.1 Endogenous Growth Models, Human Capital and Health

Since the time of Adam Smith, economists have sought to discover what makes a nation wealthy. The idea was formalized in the concept of an aggregate production function which posits aggregate output to be a function of three primary inputs – the stock of land, labour and capital, Y= f(L,K,T). The wealth of a nation was believed to grow steadily as the stock of these variables (labour, capital and land) increased. Later Neoclassical growth theories, like Solow (1956), Koopman (1965), Cass (1965), gave an interesting insight to the theories of

economic growth by introducing the concept of diminishing marginal returns to capital. The apparent emphasis of Solow (1956) model was on the fact that small economies with low initial stock of capital are likely to grow faster than the large economies due to diminishing marginal returns to capital and the growth rate of a nation tends to be inversely related to the initial levels of per capita income. This leads to convergence of growth rates among the countries (Barro, 1991). This hypothesis gave a different dimension to the literature of economic growth. However, these models didn't have adequate explanatory power to elaborate the findings of empirical studies conducted later on. Problem arose when growth of these variables could not explain the nature of output growth over a length of time (Cortright, 2001). Data of Heston and Summers (1988) showed very little correlation between initial GDP and per capita growth rate among 98 countries (1960-1985) (Barro, 1991).

One prediction of the neoclassical growth models is that, in the absence of continuous improvement in technology, per capita growth eventually must cease. This is due to the onset of diminishing marginal returns to capital. However, long run data for many countries indicates that positive per capita growth can persist for very long periods (Lucas 1988, Romer 1986). Therefore, following Solow (1956), one may conclude that long run growth is determined by exogenous factors like the rate of technological progress etc.

Long run per capita growth may well be driven by technical progress alone, but this does not mean that technical progress occurs on its own (exogenously). Human being by their conscious action and knowledge, determine the rate of technical progress and such actions should be parts of explanatory theories. This brings us to a new strand of growth theories, the endogenous growth models that focus on human capital.

Following Ray (1998), we present a brief overview of the basic elements of endogenous growth models. If we consider only physical capital and instead of labour we take human capital then we have

$$y = k^{\alpha} h^{1-\alpha} \ldots\ldots\ldots (1)$$

Now part of the output is consumed and rest of the output can be used to accumulate physical capital (k) and human capital (h). Let a fraction s is saved to accumulate physical capital and fraction q is saved to accumulate human capital.

$$k(t+1) - k(t) = sy(t).....(2)$$

$$h(t+1) - h(t) = qy(t).....(3)$$

he showed that that starting from any initial situation {h(0), k(0)} equations (1), (2), (3) causes the variables, y, h and k grow at a steady rate in long run which is determined by s and q. let the rate be r which common for y, h and k. dividing both sides of (2) by k(t) and using (1) we get,

$$\{k(t+1)- k(t)\}/ k(t) = sr^{1-\alpha}$$

which gives the growth of physical capital similarly for human capital we get,

$$\{h(t+1)- h(t)\}/ h(t) = qr^{1-\alpha}$$

Since growth rate is same in long run we have,

$$sr^{1-\alpha} = qr^{1-\alpha}$$

$$\text{which implies, } r = q/s$$

Larger is the investment in human capital relative to that in physical capital larger will be larger is the long run ratio of the former to the latter. Now, growth rate equation for k(t) tells us ,

$$\{k(t+1)- k(t)\}/ k(t) = sr^{1-\alpha} = s^{\alpha}q^{1-\alpha}$$

Therefore, the long run growth rate of all variables including per capita income, y, is given by $s^{\alpha}q^{1-\alpha}$.

Models of this kind are called the endogenous growth theories, because the pace of growth is determined by the decisions to save and to invest in human capital and physical capital – variables that are endogenous to model.

The importance of endogenous growth theories is that they introduced another factor called, human capital as a key determinant of economic growth. Human capital is essentially a knowledge skill which is embodied in minds and writings

of individuals and societies. It does not have any mass, therefore, it has to be measured indirectly (Becker, 1990). Introduction of human capital changed the direction of growth theories. Human capital is important because it helps skill formation and generation of new ideas that underlie technological progress. Therefore, contribution of human capital to the productivity improvement can not be ignored (Romer 1990, Von Zon and Muysken, 2001).

Economists like, Nelson and Phelps (1966), Lucas (1988) have emphasized on the spillover benefit of human capital in a multi-country frame-work. Becker et al (1990), Lucas (1988) et al showed that the rate of return to human capital increases over time. However, when a certain quantity of human capital is achieved subsequent growth tend to be inversely related to the increase in human capital. Therefore, like physical capital human capital is also characterized by diminishing return. Gradually different empirical studies were also carried on to support the importance of human capital in explaining cross-country differences in economic growth (Barro 1991, Barro and Lee 1996, Benhabib and Speigel 1994, Mankiw et al 1992).

Now, human capital covers a gamut of variables. Until 1990s, educational status – for instance, educational attainment, literacy rate, years of schooling (Barro and Lee, 1996), and technical skills (Uzawa 1965, Rosenberg 1963) – was taken as the primary indicator of the level of human capital. However, knowledge or technical skills, alone can not capture all dimensions of human capital/productivity. Various studies have attempted to identify different sources of economic growth; many variables were tested, but only a few were accepted as statistically significant.

Although the emergence of health economics as sub discipline dates back to the 1960s, roughly coinciding with the emergence of a related sub-discipline of the economics of education, very few authors recognized the importance of factors like health and nutrition as productivity stimulating factors that contributes to economic growth. Despite its early recognition, it was only in the 1990s that there has been a flurry of studies on the effects of health on economic growth.

Fogel (1994) and Barro (1991) were among the firsts to establish a relationship between health and economic growth. Schultz (1997) argued that health is an ultimate indicator of wellbeing of a nation. Hence, attainment of a high stock of health is important for economic development. Even at the micro level, a positive impact of health on human productivity can be established. This contributes to their wellbeing through improvement in lifetime income. Increases in income in turn support their increased expenditures on nutrition and health.

The following section presents a detailed review of the literature on health and economic growth.

2.2 Health and Economic Growth

In this section we will discuss different aspects of health–growth relations. First, we will investigate the impact of health on economic performance through improved productivity and educational status. Next, we examine how improvement in health status leads to increase in the proportion of aging population which in turn reduces growth and increases the cost of health care services. Third, we will discuss the literature focusing on reverse causal link – the impact of economic performance on health. Finally, we present the literature dealing with income inequality and health.

2.2.1 Health, Productivity and Growth

Good health is a crucial component of economic growth. It raises level of human capital and positively impacts individual productivity and economic performance. Better health increases workforce productivity and their earning opportunities and the capacity to generate higher earning facilitates increase in the consumption of health related inputs such as adequate food or medicine. Analysis of the interrelationship between health and economic performance can be performed at the individual level, the regional level or at the level of nation.

First, we discuss some of the studies at the macro level. Mankiw et al (1992), in an augmented Solow (1956) model, incorporated human capital to explain economic growth. According to them, excluding human capital from production

functions may result in misspecification errors. The direction of influence of other factors like population growth and savings rate may still be correctly estimated but the magnitude of their influence may turn out to be surprisingly large with this misspecification error. Although Mankiw et al (1992) considered education as a proxy for human capital, subsequently there have been several studies based on their framework that included health as a factor of production. These studies established health as a productivity stimulating factor (Barro and Lee 1996, Benhabib and Speigel 1994).

Others like Bhargava et al (2001) using panel data have investigated the effects of health indicators such as adult survival rates (ASR) on output growth rates. First, using ASR as an explanatory variable, their model investigated the interrelationship between GDP growth rate and life expectancy. Secondly, taking into account the interaction between ASR and lagged GDP level, issues of endogeneity and reverse causality were addressed. Lastly, they computed confidence intervals for the effect of ASR on growth rate and applied a test for parameter stability. The results showed positive effects of ASR on GDP growth rates in low-income countries.

Bloom et al (2004) estimated a production function model of aggregate economic growth including two variables that micro economists have identified as fundamental components of human capital: work experience and health. In their study, life expectancy is taken as the proxy of the health status and average work experience and the years of schooling of the work force have been considered as the other human capital proxies. Their main result is that good health has a positive and statistically significant effect on aggregate output even when we control for experience of the workforce. In their study one year improvement in life expectancy leads to four percent increase in the output level. Since this is a fairly large influence showing that increased expenditure on health care services might be justified on the grounds of the productivity and economic performance.

So far we have discussed the macro level studies. Now we focus on the studies that have been conducted at micro level.

Some studies have tried to associate health status with height and weight. Greater height is associated with greater physical strength and thus more earning opportunity. Glick and Sahn (1998) found that earnings of men is higher than that of women both in self-employment and the private wage sector, where work is likely to involve physical labour. This reflects the less physically strenuous nature of most women's activities. They considered Body mass index as an endogenous variable. Overall, their results suggest that health can significantly impact human productivity depending on gender and type of work.

Dinda et al (2006) examined that workers of above average height earn 9–17% more than their shorter counterparts and 6–13% more than average reference height. The results suggest that long-term investments in health human capital might ensure increase of labour productivity and thereby earnings, particularly in underdeveloped economies. Again, increase in obesity can lead to a considerable fall in real income. Finkelstein et al (2005) examined different causes of obesity and its economic consequences like increased medical cost decrease in income etc.

2.2.2 Health, Education and Growth

Another set of literature explains the impact of health on economic performance through improvement in educational status of the citizens (Edwards and Grossman 1979, Shakotko and Grossman 1981, Perri 1984, Wolfe 1985, Berger and Leigh 1989). Although cross-country correlations between various measures of health status and income, conditional on education, are extremely strong (Bloom and Shachs, 1998), the micro evidence on the impact of health on individual labour productivity (as measured by wage), controlling for education is often rather weak (Strauss and Thomas, 1998). Poor health reduces individual's ability to acquire skill and knowledge and thus lowering life time earning.

Though a large body of literature has been developed to explore the impact of education on health status only a few have looked at the issue of effect of health on education.

Empirical research of Glewwe et al (2001) presented a cross-sectional study which shows that delayed school enrolment in Ghana is related to child growth stunting. Mendez and Adair (1999) examined the impact of stunting in the first two years of life on cognitive ability test scores and school enrolment at age 8-11 and found strong evidence consistent with a large impact of improved nutrition on subsequent performance in Cebu. Alderman et al (2001)using a panel data set showed that in rural Pakistan, childhood health and nutrition have large consequences for school enrolment. Leslie and Jamison (1990), Myers (1992) argued that better health is associated with better school enrolment and gains from schooling like more grades, less absenteeism etc.

Behrman (1996) showed that child health and nutrition are strongly associated with educational achievement. But associations do not necessarily indicate causality; estimates generally are likely to be biased in one direction or the other. As a result analysts and policymakers should have much less confidence in findings about the effect of health on schooling success than has been claimed in previous surveys. The evidence is more nuanced and qualified than is often recognized. But they may still support the conclusion that health has considerable impact on post schooling productivity. According to Behrman (1996) policy implications point toward providing public subsidies for the collection, analysis, and dissemination of information about the links between health and education; and toward providing services to improve the health of poor children.

2.2.3 Health Improvement, Aging Population, Increased Cost of Health Service

Another stream of literature examines how aging population influences long-term growth. The link between health and productivity encourages the countries to invest a significant proportion their GDP for the efficient provision for healthcare services. For example in 2000, Japan became the third country following Netherland and Germany to establish public long term health care insurance. Virtually all these countries share common demographic characteristics with a rising proportion of older population increased. If the proportion of aging population increases then it has two consequences. First, with the increase in older population, the ratio of people who dissave to the working people who save will increase. This will slow down the growth rate by reducing capital accumulation.

Secondly, as the proportion of the aging population increases, the demand for hospital beds, other equipments, long term medical care facility for elderly also increases over time leading to a rising costs of medical care services. Indeed the consequences of long term health improvement that leads to rising aging population, in turn induced greater demand for health care services and leads to medical care costs.

Now we will discuss the negative impacts of aging population on economic growth. Aging population along with increasing cost of health care has attracted much attention from economists, who have attempted to understand the causal effect on economic growth. Faruqee and Muhleisen (2003) developed a general equilibrium framework to examine the economic implications of population aging in Japan. His main focus was on aggregate savings behaviour which has been modelled by using the age earning profile of the lifecycle hypothesis. The study estimated the output loss caused by demographic changes and assessed the impact of aging on Japan's government finances. Theoretical studies such as Cipriani (2000), Croix and Licardro (1999), Zang et al (2001) have generated an inverted U shaped relationship between life expectancy and growth. Tabata (2005) using an overlapping generation model, showed that life expectancy, when relatively high, negatively affects economic growth and vice versa.

However, the relationship between demographic transition and economic growth is not as straight forward as described above, but a rather complex issue. It is true that growth of output can be influenced by the savings rate, but on the other hand, the growth rate of the savings can also be influenced by the growth rate of income. This is because faster growth rate of income will reduce the ratio of elderly people's consumption to current income (Modigliani, 1986). Using the same logic Futagami et al (2001) investigated how population aging affects economic growth in a general equilibrium framework using endogenous growth model. It shows that if we incorporate an old age pension system then population aging is not necessarily a negative factor for growth and the postponement of retirement age can decelerate growth.

Therefore, it can be concluded from the above studies that there are two opposite forces determining the final impact of aging population on economic growth.

Blumenthal (2001) has shown his concern about the increased cost of health services in the context of aging population. Among others who have discussed health expenditure related to aging population are Anderson and Hussey (2000) for industrialized countries, McGrail et al (2000) provided a detailed assessment of health costs by age associated with decedents and survivors in British Columbia Deaton and Spencer (2000) survey the literature relating to economic (including health care) costs of population aging and explored the impact of population change on the requirement of physicians in Ontario.

2.2.4 The Reverse Causality: from the wealth to health

Now the effect of health on economic performance is quite clear. However, the direction of causation remains an open issue. One possible line of reasoning is that individuals with more wealth can afford better standard of living, medical care, sanitation etc leading to better health. Again, healthier individuals with higher productivity will be able to work more than those who are ill, enabling them to accumulate more wealth. There are three dimensions of this analysis. First, there could be a positive effect of wealth or economic performance. Second, there may be a negative impact of wealth on health. Finally, income/wealth inequality affects health. We discuss each of these dimensions below.

Positive Impact of Wealth on Health

We will concentrate on macro level studies first. Economic growth has succeeded significantly in reducing poverty and improving the nutrition status. The number of absolutely poor people in developing countries fell from 1.3 billion to 1.2 billion and the proportion of people living in extreme poverty fell from 29% to 23% over the past decade (World Bank 2004). The annual growth rate of the gross domestic products (GDP), in China, for example, was 8% in the past two decades—the highest rate in recent world history. As a result, the proportion of the absolutely poor population in China decreased sharply from 80% in 1978 to less than 12% in 1998; the proportion of the extremely poor decreased from 20%

to 6% during the same period (State Statistical Bureau 2002). If the poverty level decreases then more people can access the benefits of medical care service and thus there health status may improve.

Pritchett and Summers (1996) have estimated the effect of income on health by using cross-country time series data on infant mortality rate, life expectancy and per capita income. They found that the long run income elasticity of infant and child mortality in developing countries lies between -0.2 and -0.4. Their study concluded that over a half a million deaths of children in developing countries during the 1990s is due to poor economic performance in the 1980s.

Barro (1991) also estimated a negative impact of income on fertility rates. The theories which are concerned about the contribution of income to reduction in fertility rate and thus economic growth refer to the theories of fertility (Barro 1988, Caldwell 1982). These theories explain the pattern and economic causes of fertility changes over time. Wu (2003) and some other economists empirically tested that healthier people are likely to work more and thus earn more. Therefore, they can afford better standard of living and medical care.

Cooper et al (2006) collected data from the European Community Household Panel for the years 1994–2002 across 13 European countries, on Physical and Mental Health Problems. They have used some socio economic indicators to test for its impact on health status. The results suggest that unemployment has significant effect on duration of life but it is more severe for female than the males. On the other hand income has far less an impact and it is more prominent for the elderly people than for the young. They have also investigated the beneficial effects of other socio-economic indicators like education marital status etc.

So far we have discussed the macro level studies, now we will focus on the micro level studies.

The causal links between health and economic resources have long been understood by social scientists. Meer et al (2003) analyzed the impact of wealth on an individual's health status. They argued that inheritance is a suitable

instrument for capturing change in wealth. The results of their study suggest that the causal relationship running from wealth to health may not be as strong as it first appears. Though apparently wealth exerts a positive and statistically significant effect on health status, it is very small in magnitude. They concluded that the wealth-health connection is not driven by short run changes in wealth.

Miller and Flanders (2006) developed an empirical model in which an individual's health is a function of his/ her own income and the incomes of those who live in the same geographical area. They estimated a micro model of individual income to analyse the effects of income on mortality rate using data on the mortality rates of people categorized by age, race, gender, and place of residence. They found no association between having a wealthy neighbor and high mortality rate holding own income fixed. Instead, for some particular demographic and age groups—in particular working-aged black males—having relatively wealthy neighbours is associated with lower mortality. For example, among younger (aged 25–64) a black man, an increase in the income of others is estimated to have a beneficial effect on mortality which in turn has a positive impact on the income of black men.

Perotti (1996) found that greater income share of middle class has a strong negative effect on fertility and it has a significant effect on economic growth. Fuch (1986) argued beyond a fairly low level of provision of food, Hygiene and basic health care it is standard of living that causes greatest variation in health status. Hurd and Kepteyn (2003) have also established a causal link between wealth and health. In an empirical study Levy (2000) found that number of nights spent in a hospital is negatively correlated with changes in wealth for those individuals who do not have any health insurance.

However, there is a debate over the issue whether wealth should be taken as the appropriate measure of wellbeing of an individual. Smith and Kington (1997) noted that income in a single year may not be an adequate measure of the financial resources available to an individual over the expected life time in which decisions affecting health are made. Similarly and Feinstein (1992) suggested that the issue

of reverse causality is likely to be associated with household wealth than household income measures, primarily because wealth accumulates over time.

Negative Impact of Growth on Health

From the development perspective, the effects of growth on health status have generally been viewed as beneficial. Higher income is associated with better quality diets, better health care, lower morbidity and mortality etc. On the other hand, as income increases, dietary changes include higher energy and fat intakes, increased consumption of processed foods etc—which may be harmful for health. It might lead to increased obesity and different improper diet related diseases. However, the issue of such detrimental effects of income on diet has rarely been explored. Few researchers focused on outcomes such as obesity or cardiovascular diseases; how income change impacts decision making for food consumption and how food structure shifts as income increases (Guo et al 2000, Popkin et al 1995).

The study Gerdtham and Ruhm (2006) used aggregate data for 23 OECD countries over 1960–1997 to examine the relationship between macroeconomic conditions and deaths. The main finding is that total mortality and deaths from several common causes rise when labour markets strengthen. A 1% point decrease in the national unemployment rate is associated with growth of 0.4% in total mortality and the following increases in cause-specific mortality: 0.4% for cardiovascular disease, 1.1% for influenza/pneumonia, 1.8% for liver disease, 2.1% for motor vehicle deaths, and 0.8% for other accidents. These effects are particularly visible for countries with weak social insurance systems, as proxied by public social expenditure as a share of GDP. Different reasons have been suggested for this peculiar aspect of health worsening in good economic condition.

First, with high employment, leisure time decreases making it more costly for individuals to undertake time-intensive health-producing activities such as exercise. Data from different sources also suggests that a society with good economic condition is associated with increased smoking and obesity, reduced physical activity worsening health condition.

Second, health may be an input into the production of goods and services. Therefore, working environment and type of environment are likely to affect individual health status. Hazardous working conditions, physical exertion of employment, job-related stress and pollution level of the industries etc could have negative effects (Baker 1985, Karasek and Theorell 1990, Sokejima and Kagamimori 1998).

Third, increases in permanent income are expected to have a positive effect on most aspects of health but income growth – particularly occurring in already wealthy countries – may nevertheless be associated with higher risks of some sources of death. For example, individuals drive more when times are good and may be more likely to do so after consuming alcohol, with the result that vehicle fatalities (and possibly other external causes of death) raise when the economy strengthens (Evans et al 1988, Ruhm 1995).

2.2.5 Income Inequality and Health

The issue of health inequality stems from the issue of welfare distribution. By health inequality we mean differences or inequity in access to health as well as in health status. It is a general consensus that wealthier nations are healthier nation. However, this is true only when the benefits of growth trickle down to the lower segments of the population. Without a redistribution of growth, general improvement of health can not be achieved. Therefore, inequality is an important aspect in the analysis of health and economic growth.

Kawachi and Kennedy (1999) considering the relative income hypothesis explained that an individual's health status is better in societies with a more equal distribution of incomes. The adverse effects of income inequality on health may be mediated by underinvestment in social goods, such as public education and health care etc.

Deaton (2001) found that the longevity of men in the United States in the top 5 percent family income bracket in 1980 is about 25 percent more than those in the bottom 5 percent. According to Deaton proportional increases in income are associated with equi-proportionate decreases in mortality throughout the income

distribution. Therefore those who have higher income are expected to have higher health status and vice versa. This calls for redistribution of income in the interest of public health. Redistribution of income will lead to a more egalitarian society from the point of view of health status as well.

Hongbin and Zhu (2006), using survey data from China, have examined whether individual health is associated with income and community-level income inequality. Since, poor health and high inequality are features of developing countries, most of the earlier literatures have drawn data from developing countries to study the association between the two. They found that self-reported health status improves with per capita income, but at a decreasing rate. Controlling for per capita income, they found an inverted-U curve relationship between self reported health status and income inequality, which suggests that high inequality in a community poses threats to health. They also found that high inequality increases the probability of health-compromising behavior such as smoking and alcohol consumption.

Quevedo et al (2006) investigated the issue of socioeconomic inequalities and health status using European Community Household Panel Users' Database (ECHP-UDB) across European Union Member States between 1994 and 2001. Their objective was to see whether and to what extent poorer members of society face greater health problems than richer members of society, and how this varies across time. For all countries, the long-run indices show that income-related inequalities in health widen over time, in the sense that the longer the period over which an individual's health and income are measured the greater the measure of health inequality arising out of income inequality. The ranking of countries according to their prevalence of illness differs from ranking by overall health achievement, which takes account of inequalities. This means that an equity-efficiency trade-off has to be faced in evaluating the performance of different countries and in comparing countries with diverse health and social welfare systems.

Though a large number of aggregate and multilevel studies have addressed this topic of relationship between income inequality and health (Lynch et al 2000,

Subramanian 2003), there is no consensus about whether income inequality is a threat to public health. Regarding income inequality and health, two broad patterns of findings were identified. First, income inequality has not been found to have an adverse effect on health in countries that are more egalitarian (or have a stronger welfare state). In countries that are more unequal shows evidence in support of the adverse effects of income inequality on population health (Subramanian et al, 2003). Second, the most consistent association between income inequality and health appears to be at the level of the US states, where higher inequality has been linked to higher all-cause mortality risk (Lochner et al, 2001), lower self-rated health (Kennedy et al 1998, Blakely et al, 2002, Subramanian et al, 2003), higher prevalence of depressive symptoms (Kahn et al 2000) as well as a more adverse profile of health-related behaviours (Diez et al, 2000).

A relatively neglected aspect of research in this area has been a systematic examination of the differential impact of state-level income inequality on the health outcomes of different socioeconomic and demographic groups, defined by income, educational attainment, race/ethnicity, gender, and age. Surprisingly, little has been said about this question. A careful and systematic analysis, therefore, is needed to address the question of whether the effects of state income inequality on health status are more pronounced for certain population sub-groups as compared to others. The answer to this question has implications for both income inequality and health, as well as for the potential policy remedies to reduce income inequalities (Subramanian et al, 2003).

We may conclude that problems of inequality arises essentially due to different socio-economic conditions like income inequality, poor educational status, many non-economic inequalities like gender differences, racial discrimination etc. Therefore, policies, targeting at income inequality only, will not suffice. Rather strategies like providing more subsidized medical care, education etc are more effective in this regard.

Developing countries however, suffer from serious resource scarcity problem in different areas of public distribution. One possible solution could be to get

assistance or loans from the developed nations. For assistance there are no obligations of repayment. However since loan has to be repaid if is not properly used it may lead to increasing burden of loan to meet the obligations of repayment.

2.3 Determinants of Health

Apart from the medical care there are some other factors also which affect health status of citizens. To a large extent, factors such as where we live, the state of our environment, genetics, our income and education level have effects on health conditions of individuals. The determinants of health include:

Social and Economic Environment

- Income and social status - higher income and social status are linked to better health. The greater the gap between the richest and poorest people i.e. higher the inequality higher will be the differences in the health outcomes.
- Education – low education levels are linked with poor health, lower productivity, more stress and thus lower income and health status.
- Gender - Men and women suffer from different types of diseases at different ages. It has been observed that the health condition of women is much poor that that of men. Reason can be attributed to unequal allocation of resources and negligence of the girl child (parents' preference for boy child).
- Environmental degradation – environmental degradation is another factor which can pose threats to the health status of the citizens.
- Living environment- Safe water and clean air, healthy workplaces, safe houses, communities and roads, type of occupation and working conditions (people in employment are healthier, particularly those who have more control over their working conditions), area of residence have significant impact on individual's health condition
- Health infrastructure - access and use of services (doctors, health centres etc) that prevent and treat disease also influence health

- Institution in place – economic and social policies have much to do with the health status of the citizens. The type of institution in power affects the policy formulation regarding the way in which resource will be allocated and spent in the health sector.

Individual Characteristics and Behaviours

- Genetics - inheritance plays a part in determining lifespan, healthiness and the likelihood of developing certain illnesses. Personal behaviour – balanced eating, smoking, drinking, and how we deal with life's stresses and challenges all affect health.
- Health behaviour- health related behaviour like smoking, alcohol consumption, self harm or different addiction then preventive health care measures are classified as health related behaviour which al influence individual's health status.

Consideration of the determinants of health in cross-country economic analyses has previously been somewhat limited by the lack of available data and suitable analytical techniques. Recently, more comprehensive cross- country database has enabled us to apply suitable techniques for the econometric analysis of determinants of health. A brief review of the literature is discussed below.

The studies which address the reasons of variation in health status mainly try to find the link between economic condition and health. The role of lifestyle or ***standard of living*** in determining the health condition has already been discussed in the literature of causal link between health and wealth. All of these studies have mainly associated better health condition with higher level of income. Higher income generates better standard of living and more affordability of healthy environment. Therefore, higher income leads to higher health status with few exceptions (affluent people consumes more alcohol, cigarette, fat producing food etc, which has a detrimental effect on health) in this sense illness or disability is basically a function of economic condition (Currie et al., 2006, Contoyannis and Jones, 2004). Again, higher degree ***of income inequality*** also increases gap between rich and poor that contributes to health inequality. This is particularly

visible in the developing and less developed countries. (Kimhi 2003, Wildman 2003, Contoyannis and Forster 1999, Kakwani et al, 1997).

However, socio-economic status does not only include income condition. Other macro economic factors like rate of unemployment, educational status of the citizen, degree of inequality etc have also important role to play.

Effect of ***employment status*** on health condition can be estimated after controlling for the number of characters like age, gender, and education etc. Unemployment is expected to have a negative impact of on the physical and mental health status because unemployment leads to lower economic condition and lower economic status (Martikainen and Valkonen 1996, Clark and Oswald 1994, Gerlach and Gesine 1996, Cooper et al, 2007, Bartley et al, 1994). Rantakeisu et al (1999) have identified the financial hardship and shaming experiences associated with unemployment (including poorer social life, lower self-confidence and fewer leisure activities) as being important contributory factors to poor health conditions.

Discrimination against women has received considerable attention in public discussion recent years. ***Gender discrimination*** not only harms women's health, it also poses threats on the society by harming health of the off springs as well. Maternal deprivation, undernourishment of the mother affects health of the fetus, which will lead to long term health risk and will be extended beyond childhood to adulthood. Apart from this, negligence to the girl child, inequality in resource and time allocation for upbringing of the children and health care also contributes to the poor health condition of the women (Dr`eze and Sen 1989, Harris 1990, Kanbur and Haddad 1990).

Among all socio-economic factors ***education*** perhaps is the most important determinant of health condition. Almost all studies show that education strongly contributes to a better health (Behrman and Wolfe 1989, Berger and Leigh 1989, Gilleskie and Harrison 1998, Hartog and Oosterbeek 1998, Kenkel 1991, 1995, Leigh 1998). It increases scope for skill formation and thus employment opportunities by increasing productivity, creates knowledge about how to live a

healthy life etc. Therefore, education has a direct impact on health through the pathway of productivity (Grossman 1976, Grossman and Joyce 1987, Taubman and Rosen 1982, Berger and Leigh 1989, Behrman and Wolfe 1989, Kenkel 1991, 1995) and it also has an indirect effect which affects thorough upbringings, maternal awareness, preference for education and health etc. (Rosenzweig and Schultz, 1983).

Another factor which poses threat to heath status of the citizens is ***environmental degradation***. In the early stages of economic development, a country would be unwilling to trade consumption for investment in environmental regulation, hence environmental quality declines. Once the country reaches a threshold level of income, its citizens start to demand improvements in environmental quality and this leads to the implementation of policies for environmental protection and, eventually, to reductions in pollution. This view provides a possible explanation for inverted 'U' shaped environmental Kuznets curve (EKC). Panayotou (1993), Selden and Song (1994) and Grossman and Kreuger (1995) presented initial evidence that, some pollutants follow an inverted- U shaped curve with respect to income. Several economists have tried to associate EKC with health status. With regard to health there have been a number of studies regarding the cross country study of environmental impact on health (Gerdtham et al, 1992). Gangadharan and Valenzuela (2001) found that the health gains obtained through improved incomes can be negated to a significant extent if the indirect effect of income acting via the environment is ignored. A number of previous studies in this literature have found negative income elasticity of infant mortality rate associated with environmental degradation (Flegg 1982, Pritchett and Summers 1996).

The debate about how the countries have improved health outcomes has two popular arguments. First is economic growth and related nutritional gains. Secondly, importance of public health measures such as communicable disease control, immunization programme, different health related programmes (health education, maternal education etc) or hazards related to vaccination programmes etc. The second issue is related to the ***organizational structure*** of the country. By organisational structure (in determining success of immunisation programme or conducting polio eradication activities) we don't only mean the political nature of

the state (Justice 2000, Madrid 1998, Widdus 1999) but also the types of different NGOs, (UNISEF 1996) self-help groups etc (Huang and Lin 2000, Hull and Aylward 2001, Madrid 1998, Miller and Flanders 2000,Wenger 2001). Several studies accounted for the 'political will' and 'political commitment' in this regard (Widdus, 1999). Some of the case studies have also pointed out a negative effect of decentralisation on immunisation programmes (Justice 2000, Madrid 1998). Role of government regarding information assimilation for rate of adoption of new vaccine and decision regarding investment in immunization programmes, public perception has also been discussed by some studies (Levine and Levine, 1997). Thus, organizational/institutional structure plays a major role in different health programme and policy formulation.

Health infrastructure like access to safe drinking eater, water supply, sanitation programme, different medical care facility also plays an important role in determining the health status of the citizen. Therefore, public health expenditure has been justifies different studies. Rivera and Currais (2004) using an extension of Solow model have argued current government expenditure has positive effect on productivity in Spain. Study of Grier and Tullock 1989 and others have concluded that public capital is negatively related to productivity and thus growth. Apart from expenditure access to doctors, health centres (Politzre et al, 2003) etc also plays crucial role in this regard.

Now, by environment mean we don't only mean natural environment but also physical environment like ***working environment***, living environment etc. If a worker is tired from physical exhaustion or cannot bear the psychological pressure at work, he or she is more likely to be absent from work than a person working in an environment of better quality. Both the physical and psychological aspects of the work situation are assumed to influence the decision regarding going to work on a given day, and cause both voluntary and involuntary absences. The physical aspect induces injuries and then sickness absence which is involuntary (Marmot et al, 2002, Ose 2005, Drago and Wooden 1992). Thus poor or unhealthy working condition can adversely affect the health status of the workers. As a result, to compensate for the health loss of the employees sometimes employers are seen to

invest in employee health (Bolin et al, 2002, Currie and Hyson 1999, Gruber 2000).

However, studies of determinant of health have been also conducted at the micro level. At individual level different ***health behaviours*** like consumption of different nutrition, alcohol, smoking, other kinds of addiction and different preventive heath care measures have significant impact on ones health. Traditionally, cigarette smoking has been more pervasive in wealthier societies. However, in the 1970s per capita consumption began to rise dramatically in poorer nations, while on balance it fell in richer ones. There is general perception that smoking is hazardous to health (Suranovic et al., 1999). Almost all of the studies regarding this literature have pointed this fact. Similar conclusion can also be drawn for alcohol consumption. However, moderate level of alcohol is not harmful for health. An interesting study regarding maternal alcohol and drug consumption and its probable impact on children health status was conducted by Wakschlag et al. (1997), where they found illicit drug use by mother is significantly associated with children's mental health problems while alcohol has a less consistent impact. However, only few of the studies considered the off setting health measures like nutrition intake against smoking and drinking. Dietary quality (foods high in animal proteins) and traditional knowledge of medicinal plants are related to health measures (Komlos, 1995).

2.4 Health Production Function

We have already introduced the concept of health production function in our first chapter. There are some studies that have attempted to estimate health production functions. We present a brief review of these studies in this section.

Bolin et al. (2002), using a framework where all the family members have similar preference pattern and Nash bargaining strategy has shown that the production of family health is basically a function of the investment made by both the spouses. Each spouse makes investment in his or her own health and on health of other spouse and children considering health investment decision has already been taken

by the other spouse. Health status here is a function of health investment and strategies taken by the spouses.

Thronton (2002) estimated a health production function for US where he considered mortality rate is a function of medical care, socio-economic factors like education and income; different life style factors like smoking etc and environmental factors like urbanization, manufacturing activities, crime rate etc. He found that life style and socio-economic variables have substantially larger marginal impact on mortality rate than that of medical care.

Fayissa and Gutema (2005) estimated health production function for Sub-Saharan-Africa where they considered health status as a function of socioeconomic and environmental variables like income, illiteracy, pollution, urbanization, health expenditure etc. though their result suggest that food availability, income, reduction in illiteracy rate are strongly associated with improvement of life expectancy, even then their overall result suggests that provision of health service, different health programmes have little to do with the improvement health status of the citizens.

Though these two studies have been conducted in countries with completely different current economic background, the common point to be noted here is both of these are primarily emphasizing less on provision of health care and more on socioeconomic factors like income, education etc. Therefore, a general conclusion that can be drawn from these studies is irrespective of current economic status a macro level improvement in income and educational status can be translated into an improvement in medical status. These findings are supporting our previous literature regarding health and economic performance. However, the issue of decreasing returns to scale in health production function has not been addressed in these two studies.

Stickeles and Yazbeck (1998) developed and estimated a structural model of health production function that determines both demand for leisure and demand for consumption of elderly people. The health production function has two components. One is current investment which is created by using leisure time and

health related consumption. Second is the stock of past health produced over the life cycle. Impact of past health on current health and rate of depreciation of the health stock over the lifetime have also been incorporated in the production function. They used a dynamic programming framework based on the assumption that individuals maximizes lifetime utility subject to the time and budget constraint and production function choosing the level of leisure time and consumption of health related goods and services. Their results suggest that health elasticities of both leisure and health consumption is positive indicating a significant positive effect of leisure and health consumption on health status. The focus of the model is on the importance of dynamics on lifecycle allocation decision making and linkage of life cycle consumption expenditure on health outcomes.

Rosenzweig and Schultz (1983) have shown that health technology depends on different inputs selection by household like medical care etc along with their prices and income. Therefore, before estimating health technology it is necessary to consider household demand for different health inputs. So, they developed a behavioural model of estimation where different inputs themselves are choice variables. Importance of their study is they introduced a concept of health heterogeneity in their model which captures the unobserved influence of some exogenous factors broadly genetic and environmental. These factors are not controlled by household but they have direct impact on health and health related inputs.

2.5 Studies on India

There are some studies on health status, economic performance and health seeking behaviours in the context of India. In this section we will present a brief review of some of these studies. The relationship between health, productivity and income has been analyzed both at national (macro) level and individual (micro) level. Most of the studies on India are micro level analysis, with the exception of a handful that are macro level.

First we focus on the micro studies. Using panel data for rural south India, Deolalikar (1998) estimated a health production function whose inputs are calorie intake and nutritional status (weight-for-height) of workers. He found that both- market wage and farm output- are highly elastic with respect to weight-for-height. However, neither of these two is observed to be responsive to changes in the daily energy intake of workers. These results suggest that while the human body can adapt to inadequate nutrition in the short run, it cannot adapt readily to chronic malnutrition that eventually results in loss of weight for- height.

Another study by Duraisamy and Sathyiavan (1998) on health, wage and labour supply revealed that a 10% increase in the body mass index of males and females leads to an increase in their wage by 7% and 2% respectively and their labour supply also increases by 20% and 11% respectively.

Kannan et al (1991) investigated the issue of health status in Kerala. In their study households are categorized in to two categories on the basis of their socioeconomic status and living environment condition. Their findings are two-fold. First they found the remarkable decrease in Kerala's mortality statistics has been a result of medical interventions preventing death. Second, there had been a shift in Kerala's demographic structure, with a higher proportion of adults and aged than the all-India average. These groups are more susceptible to diseases, and thus Kerala's morbidity statistics were high. Thus, Kerala had a high prevalence of communicable diseases.

Duraisamy (2001) in a study of rural India examined the determinants of health status using NCAER-HDI (Human Development Indicator) national-level survey data for 1994. In his study health status is defined in terms of illness prevalence rate and functional disability based measures. The study suggests a U-shaped relationship between age and morbidity. Regarding the determinants of heath status he found that both, education and income exert a negative impact on morbidity and primary-level education, household income, and village-level infrastructure and amenities contribute to increase the probability of choosing private health care over any other type of facility.

Gupta (2005) found health related behaviours, especially smoking and tobacco use, are major determinants of health and lead to health inequities. Smoking leads to acute respiratory diseases, tuberculosis and asthma in younger age groups and non communicable diseases such as chronic lung disease, cardiovascular diseases and cancer in middle and older age. He also observed an inverse association of educational status with tobacco use (smoking and other forms) in western Indian State of Rajasthan.

Among the macro studies, World Bank (2004) examines the effects of per capita GDP, per capita health expenditure and female literacy rate on infant mortality rate using state level data for the period 1980-99. The econometric results of this study explain that both per capita public spending on health and per capita GDP are inversely related to infant mortality rate and prescribes for more public spending in health sector of India.

Gupta and Mitra (2003) examined the relationship between health poverty and economic growth in India based on data of fifteen measure Indian states. Their econometric analysis showed that per capita public health expenditure positively influences health status and growth and health has a positive two-way relationship.

Mahal (2005) considering a panel data for 1970-71, 1980-81, 1990-91, 2000-01 and fourteen Indian states found a strong association between per capita income and health status (Life expectancy and infant mortality rate). Apart from income other variables like years of schooling completed, per capita health expenditure also turned to have significantly positive impact on health status. His study also confirms the reverse causality i.e. a positive and significant effect of life expectancy on state level domestic product.

The macro studies, by and large, confirm that richer states are also the healthier ones. However, these studies do not examine the complex interplay of several factors shaping macro level health outcomes, as described above within the comprehensive framework of a health production function (see figure 1.2 in chapter 1). This is precisely what we attempt to do in this thesis. Our objective is

to examine the role of health in economic performance in the context of India through the analysis of the determinants of health outcomes (a health production function) and estimating the role of health in India's economic performance.

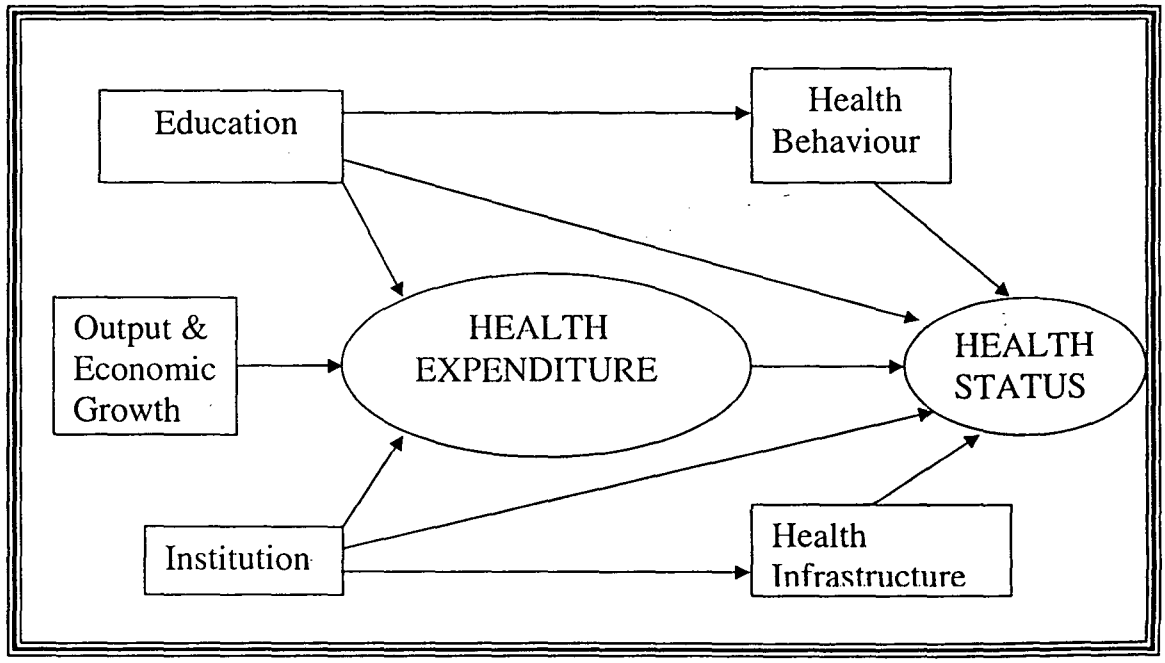
Chapter 3: Health Production Function

Based on the theoretical and empirical literature, discussed in chapter 2, this chapter has a two-fold objective. First, we develop and estimate econometric models of health production function using state level secondary data from India. Second, we attempt to estimate how efficiently each of the states in India produces the "health outcomes" from "health inputs", using the Data Envelopment Analysis (DEA). Sections 3.1 to 3.6 deals with the econometric estimation of the health production function while section 3.7 presents the DEA study.

3.1. Econometric Estimation of the Health Production Function

The econometric analysis seeks to analyse not only the determinants of health status within a well-specified production function, but also how the determinants interact with each other. The structure of the underlying relationships within a health production function framework is represented by the following schematic diagram.

Figure 3.1: Determinants of Health Status – A Schematic Framework



The above figure shows how health status is determined by a complex interplay of various heath inputs, like health expenditure, health behaviour, health

infrastructure, institutions and education. However, in estimating a health production function, we can not consider all input variables as exogenous – particularly so for the health expenditure input, which is endogenously determined within the system itself. Accordingly, as depicted in the schematic diagram, we must a have specification of the determinants of health expenditure as well. In fact, we have used oval outlines to indicate endogenous variables and rectangular outlines to indicate exogenous variables in our schematic diagram.

3.2 Testable Hypotheses

We, thus, have two broad sets of testable hypotheses. The first pertains to the determinants of the health expenditure and the second pertains to the determinants of health status. We discuss each set of testable hypotheses in the following subsections.

3.2.1 Determinants of Health Expenditure

Gross Domestic Product or Income of the States

GDP per capita is expected to have a positive impact on health status because higher level of income can finance consumption of higher quality of goods and services, better housing, medical care services and nutritional expenditure etc., which favorably influence health status. However, if the average level of income of the citizens is low, expenditure in social sectors like education and health is reduced to cushion the basic necessities like food, housing etc and thus expenditure for health and education are reduced. Similarly, if GDP of a state is high that state can afford to spend more on health sector than the backward states.

Education

Education creates awareness not only about individual's own health but also about others. For example, female literacy or education influences the health condition of children, which also affects their cognizant ability. Therefore, more aware, conscious and educated individuals are expected to invest more for health causes. This micro level relationship between health expenditure and education is also reflected at the macro level. If the average level of education of citizens of any state is higher then that state invest more in social sectors like health.

Institutions in Place

Allocation of resources in the health sector and functioning of the health care delivery system in India greatly rely on the policies designed by government. Therefore, political nature of the government in power plays an important role in decision making. For example Marxist or Socialist governments are expected to put more emphasize in the social sectors like health and education and therefore, social sector is likely to develop more. However apart form political institutions, social institutions like different NGOs also play important role in this regard.

Given the mixed economy nature of Indian economy policies have been designed in a manner so that health sector also receives considerable amount of attention. Presently in India more than twenty six centrally sponsored health schemes are being carried on by different government institutions and district level health societies. Special attention have been given to maternal and child health. Rural, urban health gap has been tried to be bridge through different rural health programmes etc. Apart from the government, contribution of different social institutions, like UNICEF, WHO to health sector promotion in India, can not be ignored.

World Bank
Idea of it includes
family planning

3.2.2 Determinants of Health Status

Health Expenditure

We have already explained the factors that influence health expenditure of a nation. Perhaps expenditure is the most important input of any production as it helps to gather other physical inputs required to produce output. In health sector also expenditure is necessary for building up hospitals, health centres, provision of other medical services etc.

In spite of large positive externalities associated with health spending, in India, until now health sector is largely privately financed. On the financing source, NHA 2001-02 comes out with a clear message that is familiar to many. The major financing source of health care in India is the household which accounts for 72% of total health expenditure through out-pocket-payments and insurance premium.

The contributions of State Governments and the Central Government and Local Governments to total health spending are 13%, 6% and 1% respectively. Public and private firms which provide medical benefits to their employees and dependents contribute 5% while external support accounts for 2% of the total health expenditure. Broadly speaking therefore public expenditure constitutes a meagre 20% of India's total health expenditure. With regard to financing agents, households manage 70% of total health expenditure, firms about 4.5%, while state local and central governments account for 13%, 3% and 2.5% respectively. Likewise, in terms of use of health expenditure, private providers account for the major bulk of 69.6% of health expenditure while public providers account for 23%. Finally, in terms of health care functions, 75% of health expenditure in India is geared towards curative care, 11.3% for RCH, 1.5% for disease control and 1.8% for medical education and training. (NHA, 2001-2002)

Abysmally low public spending in health sector in turn has two consequences.

First, since the value placed on health is increasing, even the poor households now are willing to spend and incur debt to ensure minimum health care. Since the number of consumers has been increased with limited resource availability, the benefit of public spending has been thinly spread worsening the quality of health care and thus reducing the access to reliable public health services.

Second, as the government-run hospitals and clinics are starved of public funds they were compelled to introduce user fees (especially after introduction of World Bank assisted health projects) making the citizens pay more for medicines, diagnostic procedure and surgical aids. Since, poor people are likely to spend relatively less than the rich, the gap between health status of poor and rich, has been increasing. Therefore, there is an immediate need of government intervention in the provision of health care delivery system.

Health Infrastructure

Health infrastructure implies the state of basic facilities and capital equipment needed for proper functioning of health sector. It includes different health care providers like primary heath centres, community health centres, subcentres, urban

and rural hospitals, dispensaries, health man power, specialized doctors and nurses, water supply, sanitation and other equipments which help to promote health care service. It is purely a supply side consideration of health economics and as more population is covered by better infrastructure more improvements in health status are likely to occur.

Education

There is a general consensus that education facilitates output growth through improvements in labour productivity. However, a more detailed analysis of the issue helps us to understand that education also has an indirect impact on an economy through improvements in health status by creating health awareness. Health-related behaviour such as use of tobacco, alcohol consumption, exercise, leisure-time activities, food habits, personal hygiene conditions etc have considerable effects on health status of individuals. These factors are mostly guided by the individuals' general health awareness which is in turn influenced by their education status. This relationship can be translated even at the macro level. If the citizens of any state are more educated then that state is like to exhibit a higher health status. For example, while Kerala, a better performing state, exhibits both-very high literacy rate as well higher life expectancy and lower infant mortality rate together, states like Bihar and Uttar Pradesh etc which are relatively economically backward, exhibit lower health status along with lower literacy rates. Therefore, one can easily establish a causal link between health status and education.

Institutions in Place

Institutional nature of a state plays a major role in health sector promotion. These institutions are either political or social in nature. As mentioned earlier, political nature of a state determines the pattern of allocation of resources and different socio-economic policies for development of health sectors of the states. However, apart from the political institutions, different social institutions, like many NGOs, also play an important role in determination of health status of the citizens. They sometimes act like pressure groups and create social pressure on the government to adopt policies and decisions which, in turn, can help to promote health sector

and thus health status of the states. Therefore, importance of institutions as a determinant of health status should not be ignored.

3.3 The Econometric Model Specification

To test the above hypothesis we specify the following econometric models of estimation. As mentioned in the hypothesis, the models are grouped into two categories.

1) Health Expenditure Function

$HE_{it} = \hat{\alpha}_i + \beta' X_{it} + u_{it}$, i =1,2,....,N; t=1,2,...,T, where

HE_{it}: Health expenditure in i^{th} state in period 't'.

X_{it}: Vector of determinants of health status in period 't'.

$\hat{\alpha}_i$: The individual effect for i^{th} state assumed to be constant over time.

u_{it}: The stochastic error term.

2) Health Outcome Function

$HS_{it} = \bar{\alpha}_i + \gamma' \bar{X}_{it} + v_{it}$

HS_{it}: Health status in i^{th} state in period 't'.

$\bar{X}_{it}$: Vector of determinants of health status in period 't'.

$\bar{\alpha}_i$: The individual effect for i^{th} state assumed to be constant over time.

v_{it}: The stochastic error term.

3.4 Data and Variables

To estimate the econometric models of health expenditure function and health outcome function we now describe the data and variables, as depicted in the above schematic framework of figure: 1.

3.4.1 Data

We have collected panel data for our estimation, namely data for Indian states over a period of time, 1998-2002. These are essentially secondary data, collected

from the website www.indiastat.com. Our study focuses on sixteen major states of India, namely, Andhra Pradesh, Assam, Bihar, Gujrat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharastra, Orissa, Punjab, Rajasthan, Tamilnadu, Uttar Pradesh and West Bengal. Only for these major states, consistent data for all variables over the entire panel period could be collected. There were a few missing data points in the data set and we generated them through statistical interpolation. For the other states (primarily from the north east) and union territories, there were large chunks of missing data points and hence we were constrained to exclude them from the study.

Data on state-wise per capita health expenditure and per capita expenditures in RCH and ICDH are compiled from the Lok Sabha and Rajya Sabha un-starred questions. School enrolments and literacy data are compiled and published by The Departments of Secondary and Higher Secondary Education and Elementary Education and Literacy of Ministry of Human Resource Development, Government of India. Data on per capita net state domestic product are published by Central Statistical Organisation (CSO). Political institution related data are collected from Statistical Report of General Election, Election Commission of India, for different states in various years. Data on number of NGOs in different states are mainly compiled from the Lok Sabha and Rajya Sabha un-starred questions. Health infrastructure related data are collected from the annual reports of Ministry of Health and Family welfare, Government of India and data on length of road are obtained from the issues of Basic Road Transport Statistics of India, Ministry of Transport and Highways, Government of India. Finally health status related data are obtained from the annual issues of Ministry of Health and Family welfare, Government of India for different years.

3.4.2 Variables

Health Expenditure

Financing is the most critical determinant of health system. There is absolutely no doubt about the fact that health expenditure has a positive effect on the health status of a nation if the money is properly utilised. There are many sources of health financing in India, like, tax based public sector that comprises local, state

and central government and other public sector bodies, private sector organisation financing directly or through insurance, household through out-of-pocket expenditures, external financing through grant or loans.

Tax is a mean of mobilising resources from the richer section to the actual needy, poor population. Therefore, it is likely to promote social equality. However, if in any society, health sector is largely driven by private providers then the society is characterised by inequitable distribution of resources. India being a pro-poor country should pay more attention to public sector provision of goods and services and therefore, public financing in health sector should be revised again.

We will adopt a definition of health expenditure that includes spending on curative health care services, disease prevention, reproductive and child health programmes, health promotion, medical education training and research, administration of health services and capital investment for health etc.

In our analysis central government per capita health expenditure, per capita expenditure on reproductive health care and Integrated Child Development Scheme (ICDS) together from 1998-2002 is considered as the proxy of central government comprehensive health expenditure per capita (*HE*).

Gross Domestic Product or Income of the States

It is important note at the outset that income of the current period doesn't affect the health status of current period but that of next period. If expenditure is incurred in current period then the health inputs will help to improve the health status of next period. Thus there is a gestation period between spending the money and attainments of health improvements. Therefore, to analyse the current health status it is always reasonable to consider previous period income. For our purpose capita net state domestic product of different states at current prices from 1997-2001 is taken as the income or output variable (*PCNSDP*).

Education

Perhaps the education is the most important component of human capital. In this chapter we have considered two proxies of human capital, namely, health and

education and estimated the effect of education on the health status of the different states. It affects both, health expenditure and health status of the citizens, by creating health awareness. Therefore, we have taken education as an argument in health expenditure as well as health status function.

Now, different studies have used different proxies of education. Human capital formation by means of education is not restricted to vocational or technical trainings. Literacy is the basic level of education which is required for clerical or similar kind of job. Higher level of literacy thus ensures higher level of employment. However, literacy alone can not ensure higher health status. As the level of education increases general awareness of the people also increases. Some studies like, study by Bloom et al (2001) has taken average years of schooling completed as the proxy of the educational status of the work force. They have also taken average experience of the work force as a measure of their skill formulation. Barro (1991) used primary and secondary enrolments as educational parameter.

In our estimation, we consider literacy rates and secondary and higher secondary enrolments of different states as the proxy for educational level of their citizens for the period 1998-2002 (***Lt, Enrsc, Enrhs***).

Institutions in Place

Institutions broadly include all kinds of institutions-political, social, economic etc. depending on the ideological nature of these organisations they function in different way. We consider two kinds of institutions for our study.

First, NGOs in different states represent the social institutes of different states. Ideally, per capita availability of NGO services should be taken as the proxy to the social organisations. However, it is difficult to measure services provided by these NGOs. Therefore we consider number of NGOs per capita as a proxy for services provided by the NGOs (***PCNGO***). This variable is constructed by dividing the population size of every state by number of NGOs corresponding to each year. As per capita NGO increases, then health status of the citizens are like to improve.

Second, for political institution we are considering a dummy variable called party in power (*PTY*). If the party in power both at centre and state are same in nature, that state is likely to grow faster than the others in terms of more resource allocation and better policy environment. Thus we have taken 1 for the states, where BJP or any alliance party were present during the mentioned period and 0 otherwise. States with the value 1 expected to have more fund allocated for health sector than other states having value 0. Construction of Pty is as follows,

PTY= 1, when there is same party (or alliance) both at the centre and state

= 0, when there are different parties at centre and state.

Health Infrastructure

Infrastructure consists of large number of variables like primary health centre, community health centres , sub centres, number of doctor, nurses, hospitals, beds, water supply sanitation, transport facility of the states, telecommunication etc. For different primary, community and sub centres we have first collected data regarding the number of these health centres at state level and estimated the population served by these health centres. As the number of population served by these health centres increases, burden on them also increases. Therefore, increase in population served by these health centres will have a negative health impact. However, finally, instead of considering the population served by these health centres separately, we have clubbed them up together by using Principal component method[2] and then presented it as a variable called *HC*, which represents population served by all the health centres. Other variables are like population served by hospitals (*POPHOSP*) and bed (*POPBED*) of different states is also used. However high correlation between these variables makes us drop the variable *POPBED*. Due to non availability of data regarding number of doctors we have dropped the variable, population served by the doctors. Finally, the last variable, which has been used as proxy of physical infrastructure, is the length of road per 100 square kilometres (*ROAD*). If the road infrastructure of any state is better, then it facilitates a quicker access to hospitals and health centres when needed. Therefore, development of road infrastructure may exert a positive impact on the health status of the citizens

[2] Please see appendix A.1. for a note on Principal Component Method.

Health Status

Health status is the dependent variable of our health outcome function and objective of our study is to investigate the impact of different health inputs on health status for different Indian states.

Different studies have used different variables as proxy of health status. Bloom et al (2001), Jemison et al (2001) have used life expectancy and adult survival rate respectively as proxy of health status. Again, Gerdtham and Ruhm (2006), Thornton (2002) used death rate or mortality rate as the dependent variable in their health production function. Economists have also argued for infant mortality rate and fertility rate as proxy of population health status. However, it can be argued from these studies that there are different ways of looking at health status of the citizens, but none of these variables alone can capture the entire dimension of health status. Rather they exhibit different aspects of health status. For example, life expectancy or adult survival rate essentially indicates the average longevity of population where as infant mortality rate shows mortality rate of children of different age group. Thus these two variables basically separately represent different aspects of health status but not the whole dimension of health condition of the population.

Therefore, in our study we have proposed a frame work for our study here, where we have taken both- life expectancy at birth and infant morally rate-as the proxy of health status of different states. since we can not have two output for our health production function, these variable are clubbed up together by using principal component method[3] and then we have used this variable as ***HS*** as the dependent variable for our analysis.

3.5 Estimation Method

The exact models to be estimated may be represented as:

1) $HE_{it} = \hat{\alpha}_i + \beta_1 PCNSDP_{it} + \beta_2 Lt_{it} + \beta_3 Enrsc_{it} + \beta_4 Enrhs_{it} + \beta_5 PCNGO_{it} + \beta_6 PTY_{it} + u_{it}$

2) $HS_{it} = \bar{\alpha}_i + \gamma_1 HE_{it} + \gamma_2 ROAD_{it} + \gamma_3 POPHOSP_{it} + \gamma_4 HC_{it} + \gamma_5 PCNGO_{it} + \gamma_6 PTY_{it} + \gamma_7 Enrsc_{it} + \gamma_8 Enrhs_{it} + v_{it}$

[3] Please see appendix A.1. for Pricipal Component Menthod.

The econometric model described above is a simultaneous equation model with two endogenous variables (HE and HS) and two structural equations. It is evident that this set of equations constitutes a ***recursive model***[4] where the first endogenous variable (HE) is function of exogenous variables only and the other (HS) is a function of HE and other exogenous variables. We can therefore use single equation methods to estimate the two equations without encountering any simultaneous equation bias.

We have already described the econometric models of health expenditure function and health outcome function is section 3.3. These two functions can well be described by the following general panel regression model,

$y_{it} = \alpha_i + B' X_{it} + \varepsilon_{it} \ldots (1)$

Depending upon the assumptions made for α_i, the model can be analyzed under two different frameworks. These frameworks are referred to as *fixed effects* and *random effects* respectively.

Under fixed effect, α_i is assumed to be group-specific constant term. The assumption implies that differences across various cross section units can be captured through the differences in the constant term. It further implies that each α_i is an unknown parameter to be estimated. Assuming fixed effects, y_i and X_i as T observations for the i-th unit and ϵ_i as the associated error term with T x 1 vector of disturbances, (1) above can be formulated as:

$y_i = i\alpha_i + X_{it}B + \varepsilon_{it}$; (1a), which can be further written as

$y = i\alpha + XB + \varepsilon$; (1b) where y: a n X 1 vector; α: a n X1 vector matrix; X: a n X 1 vector matrix, ϵ: a n X 1 vector matrix;

After assembling for all nT rows, we can write (1b) as,

$Y = D\alpha + XB + \epsilon$ (1c), where D: a 1X n matrix of d dummy variables with d_i being the dummy variable for the i-th unit. The α_i s are estimated as coefficients of

[4] Please see appendix A.2 for a note on Recurssive Model.

dummy variables. This model is popularly known as Least Square Dummy Variable Model (LSDV) in econometric literature. The process of estimation in this case therefore, becomes similar to that in the classical regression model. Consistent and efficient estimates of the coefficients can be obtained by applying Ordinary least Square (OLS) technique.

Under the assumption of random effects, the α_i s are treated as random variables rather than fixed constant, and are assumed to be randomly distributed across the different cross section units. They are mutually independent and also independent of the error term i.e. ϵ_{it}.
For random effects, (1) can be reformulated as,

$y_{it} = \alpha_i + B'X_{it} + u_i + \varepsilon_{it}$ (1a*); where u_i is the random disturbance characterizing the i-th observation and is unchanged over time.

The presence of random u_i s introduces correlation among errors of the same cross-section units, though the errors from the different cross-section units are independent (Maddala, 2001), this violation of the orthogonality condition creates some difficulties in OLS estimates. While the fixed effects model can be transformed into the classical regression model, and OLS can produce consistent and efficient estimates, under random effects, applying OLS results in consistent, but inefficient estimators due to correlations of errors within cross-section of units. For obtaining efficient estimators under random effects it is necessary to apply feasible generalized least square (FGLS) technique, instead of OLS.

There have been debates in applied econometrics literature over the assumption of fixed effects and random effects in estimating panel data (Chamberlain 1978, Hausman 1981).The commonly accepted point of distinction is that if inferences are to be confirmed, only the cross-sectional units are included in the study, and not to the population from which they are drawn, then it is logical to treat the α_i s as constant and assume fixed effects. However, if inference re also to be drawn fro the population from which he sample of cross section have been selected, then α_i s

should be taken as randomly distributed, and random effect model should be chosen (Green 2003, Maddala, 2001).

The decision regarding the application of fixed effect or random effect model can be decided on the basis of the results produced by the Hausman test[5].

Hausman Test

This specification test has the following hypothesis:

$H_0 = \alpha_i$ s are uncorrelated with X_{it}

$H_1 = \alpha_i$ s are correlated with X_{it}.

The test proceeds on the notion that under H_0 both OLS and FGLS will give consistent estimates but OLS will be inefficient. Thus random effect will be accepted, if H_0 is accepted. The test statistics is asymptotically distributed as chi-square with k degrees of freedom (where k relates to the dimensionality of B) based on Wald criterion.

One problem may arise in this context –problem of ***multicollinearity.*** If the explanatory variables are correlated with each other then there is multicollinearity and the correlated variables can not be used together. Presence of multicollinearity can be detected by looking at pair wise correlation coefficient using Pearson's product correlation coefficients of explanatory variables for each pair of X variables. Test statistics is given by:

$$t = [\rho^{\sim}(n-2)^{1/2}] / [1- \rho^{\sim}]^{1/2}.$$

Under the null hypothesis, $\mathbf{H_0: r = 0}$ **against** $\mathbf{H_1: r \neq 0}$, the test is asymptotically distributed as 't' with (n-2) degrees of freedom. The test for multicollinearity does not show high correlation among each pair of the explanatory variable therefore we can use all the variables for the study.

Next step is to test for the presence of ***heteroscedasticity.*** If there is heteroscedasticity problem and we under estimate the standard errors of β, then we have inefficient estimates of β. However, an appropriate estimation procedure

[5] Please see appendix A.3 for a note on Hausman Test.

should correct for this inefficient estimator of β. Thus one has to find out a consistent estimator for the variance of least square estimators of β. White (1980) has proposed an alternative method to estimate the variance of β even if the form of disturbances is not known. This is known as ***robust estimation***[6].

3.6 Results and Interpretations

Against the backdrop of our hypothesis we now describe the results of our statistical exercise. We divide this section into two broad subsections. First, we will analyse the results of health expenditure function and then we will focus on the health outcome function. We describe result in that order.

3.6.1 Health Expenditure Function Results

In the first model we regress central government's comprehensive per capita health expenditure (*HE*) on income/output *(PCNSDP)*, institutions variables *(PCNGO, PTY)* and education *(Lt, Enrsc, Enrhs)*. Before presenting our results we address the problem of multicollinearity.

To detect possible multicollinearity we calculated pair wise correlation between explanatory variables *(Table: 3.1)*. we find pair wise correlations of *PCNGO* with *PCNSDP, PTY* and *Lt, Enrsc and Enrhs* are quite low. None of the variables shows any high or moderate correlations with each others. Therefore, we can use these variables together.

Table: 3.1- Correlation Matrix of Independent Variables of Model: 1

Variables	PCNSDP	Lt	Enrsc	Enrhs	PCNGO	PTY
PCNSDP	1					
Lt	0.3523					
Enrsc	0.0100	0.1429	1			
Enrhs	0.3947	0.0607	0.3206	1		
PCNGO	0.0003	0.4247	0.3232	-0.1753	1	
PTY	0.4089	0.0442	0.0695	0.2289	-0.0610	1

Our model did not exhibit any obvious symptoms of multicollinearity, with all variables appearing with expected sign and desired level of statistical significance.

[6] Please see appendix A.4. for a note on Robust Estimation.

We, therefore, ignore the possibility of any serious multicollinearity in our problem and present the result of panel data analysis of health expenditure function in T*able 3.2.* Husman test result[7] for estimation of health expenditure function confirms our model is fixed effect model.

Table: 3.2- Fixed-effect Regression of HE on Explanatory Variables of Model: 1

Explanatory variables	Coefficient	z-values	p>|z|
Lt	2.853206	3.20	0.002***
Enrsc	-.0000206	-1.03	0.308
Enrhs	5.38e-06	0.45	0.651
PCNSDP	.0106257	2.56	0.013**
PTY	1.281625	0.05	0.963
PCNGO	140234	2.58	0.012 **
Constant	-83.21963	-1.25	0.217
R-sq(over all)	0.2329		
F(6,58)	12.49		
Prob>F	0.000		
Number of observations	80		
Number of groups (states)	16		

*-10% level of significance, **- 5%level of significance, ***-1% level of significance.

Our empirical results by and large consistent with the theoretical results explained in literature review.

Gross Domestic Product or Income of the States

Lagged per capita net state domestic product which is a proxy of states' economic condition turns out to be a statistically significant (at 5% level) variable. It has a positive impact on government health financing. The reason is simple. When the economic condition of a state is stable, then after meeting the basic requirements of the state, it can invest more in social sectors like education and health. The higher is the level of income of a state, higher will be its social sector allocation. Conversely, if the fiscal condition of any state is poor then firstly the expenditure in social sectors is curtailed down to cushion for the other sectors like agriculture,

[7] Please see appendix A.5 for the results Husman test for health expenditure function.

industries, etc. Therefore, the social sectors suffer. Thus states' lagged aggregate level of output or income is an important determinant of health expenditure.

Educational Status of States

We have taken three variables to present educational status of the states namely literacy rates, secondary enrolment and higher secondary enrolment of the states. Among these, literacy rate is significant at 1% level of significance with a positive impact on HE. Secondary and higher secondary enrolments are insignificant. It can be therefore inferred that if the literacy rates of the states increases then people will become more aware of their health condition and demand for better medical service will increase forcing the government to invest more in health sector.

Institutions in Place

Coefficient of *PTY* is positive but not significant. Therefore, presence or absence of same political party both at centre and state does not have any significant impact on health status. However, another institutional variable *PCNGO* is positively affecting the health expenditure and the coefficient is significant at 5% level of significance. Therefore, it can be concluded from our analysis that though differences or similarity of political parties both at centre and states do not exert much impact on the health expenditure, but NGOs at the sates level can significantly influence government expenditure decisions by creating public awareness and pressuring government to invest more in the health sector.

3.6.2 Health Outcome Function Results

Analyzing the correlation coefficient among the explanatory variables wee see the all of the variables except *POPBED* are either moderately correlated or share a very low correlation with others. However, *POPBED* is very highly correlated with *POPHOSP*. Therefore, to avoid multicollinearity problem we have decided to drop *POPBED* from our analysis. Thus, now we have seven explanatory variables. The dependent variable is health status for which we have used a principle component of life expectancy and inverse of infant mortality rate and it is denoted by *HS*. Below we have described the result of our panel data analysis of health outcome function for sixteen Major Indian States. However, in context of

health outcome function, Hausman test[8] reveals that our model is a random effect model.

Table: 3.3- Random-Effect Regression of HS on Explanatory Variable of Model: 2

Explanatory variables	Coefficient	z-values	p>|z|
HE	.0015068	2.72	0.006***
ROAD	.0045554	2.82	0.005***
POPHOSP	-6.09e-07	-1.77	0.078*
HC	-.0286047	-0.39	0.695
PCNGO	133.3493	0.43	0.670
PTY	-.1240774	-0.72	0.474
Enrsc	1.26e-07	0.63	0.530
Enrhs	1.15e-07	1.77	0.077*
Consant	-1.336939	-4.23	0.000
R-sq (over all)	0.5364		
Wald χ^2 (8)	31.12		
Prob >χ^2	0.0001		
Number of observation	80		
Number of groups (states)	16		

*-10% level of significance, **- 5%level of significance, ***-1% level of significance.

Our empirical results by and large consistent with the theoretical results explained theories.

Health Expenditure

We found a positive and significant impact of government health expenditure on health status of citizens. Expenditure is significant at 1% level. As explained before expenditure helps to gather the other inputs of health production. Therefore financing is likely to have an impact on health status of citizens. However expenditure alone can not bring efficiency in the production process. How efficiently the inputs are being used- that is also another important consideration of any production process.

Health Infrastructure

Among the infrastructural variables only length of road per 100 square kilometer (*ROAD*) and population served by hospitals (*POPHOSP*) are significant at 1% and

[8] Please see appendix A.6 for the results of Hausman test for health outcome function.

10% level respectively. The coefficients estimated for *Road* is positive and that of *POPHOSP* is negative. The reason may be attributed to the fact as the road infrastructure or communication facility of any state improves, benefits can be reaped by the patients as it quicken their access to hospitals, health centres, medical clinics and thus contributing positively to their health condition. Second, if burden of patients per hospital increases, that will affect quality of hospital services, adversely affecting health status.

Among other health care related infrastructure variable we have considered population served by health centre (*HC* respectively) which is insignificant.

Education

For education we have used a variables namely secondary, higher secondary enrolments as the proxy of the educational level of the citizens. Theory explains that education has a close relation with the health status of citizens. Our study also confirms the theoretical result. Our estimation shows a positive and significant (at 10% level) impact of higher secondary enrolment on health status of citizens. However secondary enrolment is insignificant. Therefore, it can be inferred from the study that higher is the level of education status of a state the higher will be its impact on health status.

Institutions in Place

We have already explained that institutions in place play a major role in determination of health expenditure of a state and from estimation of health expenditure function we obtain a significantly positive impact of institutions on health expenditure. However, in estimation of health outcome function we haven't got any significant impact of institutions in determination of health status of the states. None of the institutional variables (*PCNGO, PTY*) appear significant in our analysis. Therefore, we may conclude institution does not have any direct impact on health outcomes but it may affect health outcomes in an indirect way by influencing the health expenditure decisions.

From the above analysis we have health expenditure, road infrastructure, hospitals and education as the important determinants of health status. Therefore, more

attention should be given to the other determinants as well, so that higher health status can be achieved. However, even if higher investment is made in the health sector, unless efficiency in utilization of resources is not achieved better health outcomes may not be obtained. Therefore, apart from availability of resources, functional efficiency is another consideration in the analysis of health production function. In the following section we present a theoretical framework for measuring efficiencies of different production units and estimate the efficiency scores of different states in production of good health using Data Envelopment Analysis.

3.7 Data Envelopment Analysis

Measurement of the efficiency of health services has been dominated by the application of cost-benefit analyses. This means how much health outcomes in terms of higher health status is achieved compared to the expenditure incurred. However, production of good health doesn't only require expenditure as the only input of production. There are some other inputs as well which play a crucial role in determination of health status of the citizens (e.g. health infrastructure, level of education of the citizens, role of different institutions in place etc) as discussed in the previous section. Even if investment is made in the health sector, unless and until that expenditure is properly utilized in terms of other health inputs, good health status of the citizens couldn't be achieved. Therefore, expenditure or investment alone can not capture the entire dimension of the efficiency aspect of health production function.

In this section we will mainly verify the efficiency of different states in utilizing the health inputs by comparing the health status achieved by them with respect to different inputs utilized. We use the linear programming based method of Data Envelopment Analysis (DEA) (Charnes et al, 1978), which has also attracted more attention recently within health economics (Kooreman 1994, Salinas et al 1994). The first section of this article provides an overview of DEA. Subsequently we describe the data set and input/output variables used in the empirical analysis, and present an illustration of the empirical model.

3.7.1 Theory of Data Envelopment Analysis

Data envelopment analysis (DEA) is a linear programming based technique for measuring the relative performance of different decision making units (DMU) where the presence of multiple inputs and outputs makes comparisons difficult. These DMU can be business units (for example points of sales, bank branches, dealers and franchisees), government agencies, police departments, hospitals, educational institutions, and even people.

A common measure for relative efficiency is,

Efficiency= (Weighted sum of outputs/ Weighted sum of inputs).

In usual notation it can be written as,

Efficiency unit= $(u_1 y_{1j}+u_2 y_{2j}+.....)/(v_1 x_{1j}+v_2 x_{2j}+....)$

u_1= *the weight given to input I,*

y_{1j}= *amount of output 1 from unit j,*

v_1= *weight given to input 1,*

x_{1j}= *amount of input 1 to unit j.*

The initial assumption is that this measure of efficiency requires a common set of weights to be applied across all units. However, problem arises regarding the selection of common set of weights. Different DMUs may choose to operate in different way and they may also value their outputs differently. For example some schools may legitimately value achievements in sport or music differently to other schools, and in general units may value inputs and outputs differently and accordingly they will assign different weights to different outputs. Therefore, this measure of relative efficiency coupled with the assumption that a single common set of weights is required is thus unsatisfactory.

Charnes et al (1978) recognized the problem and proposed that each unit should be allowed to adopt a set of most favourable weights in comparison to the other units. Under these circumstances, efficiency of a target unit j0 can be obtained as a solution to the following problem:

Maximise the efficiency of unit j0,
Subject to the efficiency of all units being ≤ 1.

The variables of the above problem are the weights and the solution produces the weights most favourable to unit j0 and also produces a measure of efficiency. The algebraic model is as follows:

$$Max\ h_0 = (\sum u_r y_{rj0}) / (\sum v_i x_{ij0}) \ldots\ldots\ldots\ldots (M1)$$

$$Subject\ to,\ (\sum u_r y_{rj}) / (\sum v_i x_{ij}) \leq 1$$

$$u_r, v_i \geq \epsilon$$

This flexibility in the choice of weights gives rise to certain problems. As the units are free to choose the most favourable weights for the inputs and the outputs, a judicious choice of weights may allow a unit to appear efficient and thus the measure of efficiency is more of choice of weights than of the inherent efficiency of their relative performance. However, if a unit turns out to be inefficient even when the most favourable weights have been obtained in the efficiency measurement then this is a strong statement and in particular the argument that the weights are incorrect is not tenable.

To solve the above model (M1) it is first necessary to convert-it into linear form so that the methods of linear programming can be applied. For the maximization of the objective function, the relative magnitude of the fraction is important not the individual values of the denominator and numerator. So the purpose will be served if we consider the denominator as constant and just maximize the numerator. Again, we transform the fractional form of the constraint of M1 to a linear form. The resultant linear program is as follows:

$$Max\ h_0 = \sum u_r y_{rj0} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (M2)$$

$$Subject\ to, \quad \sum v_i x_{ij} \leq 1$$

$$\sum u_r y_{rj} - \sum v_i x_{ij} \leq 0, j=1,2,\ldots,n,$$

$$u_r, v_i \geq \epsilon$$

The efficiency of the target unit in a set can be obtained by solving the above model. The solution to this linear programming provides the measure of the relative efficiencies of different DMUs and the most favourable weights from the

point of view of the DMUs. To obtain the efficiencies of the entire set of units it is necessary to solve a linear program focusing on each unit in turn. Clearly as the objective function is varying from problem to problem the weights obtained for each target unit may be different.

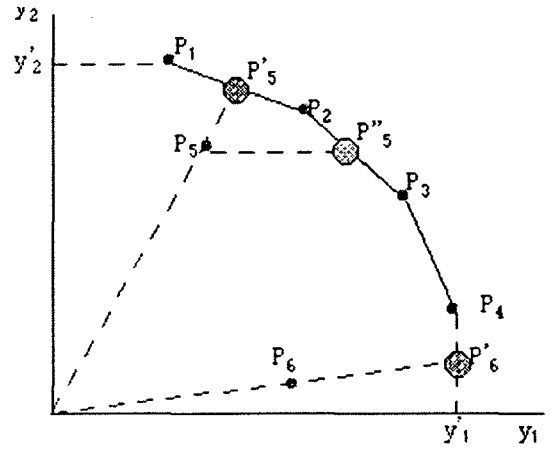
Graphical Representation of DEA

The DMUs which attain the efficiency score 1 are the most efficient units and they envelope the other DMUs. This envelope is known as the efficiency frontier. Although it is very difficult to visualize the envelope a graphical representation will allow us to understand the frontier and provide information about the potential improvement of the relatively inefficient units.

Figure 3.2 shows a set of units P1, P2, to P6 with each unit consuming the same amount of a single resource and producing different amounts of outputs, y1 and y2 as shown. For a given amount of input the unit which produces highest level of output will be efficient unit. suppose by applying the DEA approach we get units P1, P2, P3 and P4 as efficient and they provide an envelope round the entire data set units P5 and P6 are within this envelope and are inefficient. The data envelope is extended to the axes by the lines P1y2' and P4y1' to enclose the data set.

It is sometimes useful to scale the data on the peer units so that a better comparison of the inefficient unit with the peer units can be made. For unit P5 the peer group consists of the units P1 and P2 and a set of targets for P5 is provided at P5'. These targets are obtained by a pro rata increase in the outputs of unit P5. Clearly there are other possible targets for P5 and for example if the output level Y2 could not be increased for P5 then a target P5" could be set which would rely entirely on increasing output y1. For unit P6 the pro rata increase leads to the set of targets P6'. However P6' is clearly dominated by P4 which produces the same amount of output y1 but more output y2. In this case the pro rata increase needs to be supplemented by a further increase in the output of y2 to provide an efficient target. Returning to unit P5 the set of targets P5 can be obtained from a weighted average of the peer units P1 and P2. Thus P5 can be thought of as a composite unit made up of a weighted average of the peer units and this composite unit provides a target for the inefficient unit.

Figure-3.2: Graphical representation of DEA



Over the past two decades, Data Envelopment Analysis (DEA) has emerged as an important tool in the field of efficiency measurement. DEA is used to compare Decision Making Units (DMUs) such as bank branches, sales outlets, individuals or groups of individuals which use one or more inputs to secure one or more outputs. The DMUs use the same inputs and secure the same outputs but generally at varying levels.

3.7.2 Empirical Application of DEA

We have used a software package called Xldea for our analysis.

Output and Input Variables

In DEA model only two sets of data are considered: inputs and outputs. The advantage of DEA is it enables us to measure efficiency of a production function with multiple inputs and outputs. The state which produce more outputs with given or lesser amount of inputs is considered to be relatively more efficient. In our analysis the output variables are average life expectancy of the citizens and inverse of infant mortality rate and the inputs are selected to proxy government health expenditure, education and health infrastructure. Central government's comprehensive per capita health expenditure is used as the proxy of health expenditure and literacy level of the population of different states, population served by the hospital, and primary health centres are taken as education and

health infrastructure variables respectively. Reason of considering these inputs is they directly affect health outcomes of the states.

In this section our objective is to measure efficiency of different states in attainments health status. In this junction, one should remember, in social sectors, like health, return is not instantaneous i.e. if investment is made in the current year then return, in terms of higher health status could be obtained only in the long run. Since we have data only for consecutive five years (1998-2002) analysis of efficiency estimation from the output side does not fulfil our purpose. Therefore, rather than looking at the issue from the point of view of maximisation of outcomes we prefer to use an input oriented model of DEA for the measurement of relative efficiencies of different states. The input oriented model of DEA mainly focuses on how efficiently the states are using their inputs for given levels of outputs.

Our second step is to choose between variable returns to scale and constant returns to scale. Returns to scale explains, if quantity of any particular input increases by certain proportion then output may also increase by the same, less or higher proportion and accordingly we have constant, decreasing or increasing returns to scale. As we have already mentioned, returns in the health sector in terms of higher health attainments is a long run concept, then, within a short span of time even if more inputs are employed in the health sector, increase in health status can not be observed. Therefore, we choose constant returns to scale and input oriented model of DEA.

Efficiency Scores

Xldea analysis allows us to consider at most eleven states together therefore we have dropped Assam, Himachal Pradesh, Punjab and Tamilnadu from our analysis. The states are selected in such way that they can be categorised into two groups mainly developed and less developed states. Following table shows the efficiency score obtained by different states over time 1998 to 2002.

Table: 3.4- Efficiency Score of Different States Between 1998-2002

States	Eficiency scores for 1998	Efficiency scores for 1999	Efficiency scores for 2000	Efficiency scores for 2001	Efficiency scores for 2002
AP	1.0000	1.0000	1.0000	1.0000	1.0000
Bihar	1.0000	1.0000	1.0000	1.0000	1.0000
Haryana	0.7983	0.8718	0.8853	0.8589	0.9066
Karnataka	1.0000	1.0000	1.0000	1.0000	1.0000
Kerala	1.0000	1.0000	1.0000	1.0000	1.0000
MP	0.9930	0.9743	0.9791	0.9346	0.9228
Maharashtra	0.6815	1.0000	1.0000	1.0000	1.0000
Orissa	1.0000	1.0000	1.0000	1.0000	1.0000
Rajasthan	1.0000	0.9665	0.9809	0.9676	0.9306
UP	1.0000	1.0000	1.0000	0.9967	0.9396
WB	0.8240	0.7685	0.8034	0.8770	0.9906

The result, described in the above table doesn't reflect much about the efficiencies of different states in utilizing different health inputs. Though, the relative performance of some of the developed states like Kerala, Karnataka, Maharastra and Andhra Pradesh is comparatively better than the backward states like Rajasthan, Haryana, West Bengal and Madhya Pradesh, other states like Orissa Bihar and UP, though less developed, have succeed in achieving a higher efficiency score in our analysis. This is not in consonant with the fact that in reality we observe a much lower health status of these states. One possible reason may be that these states have not succeeded much in health sector promotion not because of their functional inefficiencies, but due to lack of resources. Therefore, if they are provided with more resources then we may expect a higher return in terms of higher health from them.

3.8 Conclusion

In this chapter we have focused mainly on two issues-(1) estimation of a health production Function and (2) measurement of efficiency scores of different states in production of health. For the first part we followed a recursive model structure

where we first estimated health expenditure function which is shaped by education, state level lagged per capita GDP and institutions in place and then given the health expenditure function we estimated the health outcome function, shaped by education, health expenditure, institutions in place and different health infrastructural variables. We found that education, expenditure, infrastructure and intuitional nature of the states are important determinants of health attainments. Therefore, one can look forward to a better health situation of the states if proper attention is given to these determinants. Second we estimated efficiency of health production at the state level and did not find much inter-state variation in this regard. We concluded that poor health outcomes of some of the states, therefore, is not essentially due to relative inefficiency of resource utilization but perhaps due to lack of adequate resources and appreciate facilitating environment.

Chapter 4: Health and Economic Growth

In this chapter we will try to examine the probable impact of health on economic performance on the basis of Solow (1956) growth model and its different augmentations. Taking rate of savings and population growth as exogenous, Solow (1956) examined the issue of determination of steady level income. Since savings and population growth rates vary across the countries, the steady levels will be different for each country. Subsequent empirical literatures also confirmed the findings of Solow (1956) growth model. However in latter phase several economists like Mankiw et al (1992) explained though Solow (1956) model correctly predicts the direction of influence of savings rate and population growth rates, it can not explain much about the magnitude of influences. Rather his model over estimates the magnitudes of influences. To answer this phenomenon Mankiw et al (1992) incorporated a third factor in the Solow (1956) model, called human capital, which could correctly explain the directions and magnitudes of all the factors. However much before their study economists have started to divert their attention to endogenous growth theories which incorporate human capital as the third input and determine the pace of growth within the model. Human capital is important because it helps skill formation and generation of new ideas that underlie technological progress. Therefore, contribution of human capital to the productivity improvement can not be ignored (Romer 1990, Von Zon and Muysken, 2001). In this chapter we will focus on the issue of contribution of human capital, namely education and health, on economic performance of the states with special emphasis on health.

4.1 Testable Hypotheses

The objective of this chapter is to model the determinants of economic growth with an emphasis on health and to estimate a growth function using panel data for sixteen Indian states over the time, 1998-2002. We develop an analytical framework within which issues of state of technology of the states, human capital development, physical capital formation and population growth can be discussed. Accordingly, we posit the following testable hypotheses pertaining to the determinants of economic growth.

Initial Level of Income of States

For a given starting value of GDP and human-capital, a country's subsequent growth rate is substantially negatively related to the initial level of GDP. This supports the convergence hypothesis of neoclassical growth models. A poor country tends to grow faster than a rich country, but only for a given quantity of human capital e.i only if the poor country's human capital exceeds the amount that typically accompanies the low level of per capita (Barrow, 1991). The idea is very simple. Once the poor countries reach a certain level of human capital then returns to human capital is much higher for poor countries than the rich countries due to diminishing returns. Therefore, poor countries tend to grow faster than the large countries in short run and in long run the growth rates will converge to the steady levels. This explains the negative impact of initial level of income of the states on their economic growth.

Human Capital

Human capital consists of education and health. Education includes academic degrees and different training programs, which together facilitates skill formation, innovation of new ideas and products etc. Thus returns to labour with skill is much higher than that without skill. Mankiw et al (1992) estimated without human capital returns to labour is about 30%- 50% of average wage of manufacturing sector in U.S. and with human capital it is between 50%-80%. Thus education plays a crucial role in determining the productivity of the workforce.

Second important variable of human capital is health. However, earlier, education was considered to be the only form of human capital, contributing significantly to economic growth. Recognition of health as another component is very recent. Health along with education increases individuals' productivity by contributing significantly to their physical and intellectual ability. A healthy and educated person is likely to be more productive than an unhealthy and uneducated person. Therefore apart from physical capital, human capital also contributes significantly to economic growth.

State of Technology

Solow (1956) in his study examined how population growth along with technology growth rates contributes of output growth of a country. For technology growth we need to look at the new growth theories. New Growth Theories emphasize that economic growth results from the increasing returns associated with new knowledge leading to new technology innovations. Therefore, with technology growth economic growth also increases. However, markets fail to produce enough knowledge because innovators cannot capture all of the gains associated with creation of new knowledge. Thus producers sometimes do not have incentives to innovate new knowledge. However to motivate new inventions and knowledge creation often protections in forms of different intellectual property rights are provided to the producers so that they can gain from their innovations.

The association between increasing returns and knowledge has important implication for economic development. It explains the importance of investing in new knowledge creation to sustain growth. Policy makers need to pay careful attention to all of the factors that provide incentives for knowledge creation (e.g., research and development, the education system, and entrepreneurship) so that return can be obtained in form of higher economic growth.

Investment

Apart from population and state of technology, theories by Solow (1956), Koopman (1965) and others, also focuses on physical capital as another important growth determining factor of production. Later the endogenous growth theories substituted human capital for labour but the importance of physical capital still remains the same. There are two important concepts associated to physical capital. First, stock of capital and second, addition to the stock of physical capital termed as investment. It is the second i.e. investment relative to nation's GDP, which is crucial for determination of growth. Addition to stock of capital leads to more capital availability per worker and thus increasing their productivity. Empirical studies also mostly use ratio of investment to GDP as a growth stimulating factor for estimation of growth (Barro, 1991, Mahal, 2005).

Population Growth

Population growth is comprised of three different factors: Fertility, mortality, and migration. However, economic theories of mortality are very few and it is often seen as an exogenous factor. Migration, on the other hand, has been subjected to intense scrutiny by population economists and others, but dealing with this topic in any detail would require a separate inquiry. This chapter deals mainly with fertility decisions and their relation to other economic decisions, such as consumption and saving and growth.

In growth models with human capital and endogenous fertility (Becker et al, 1990), per capita growth and net fertility tend to move inversely. A higher initial stock of human capital leads to higher growth and lower fertility. Therefore, we see a negative impact of economic growth on fertility rate. Impact of population growth on economic performance is also the same. It can affect economic growth in several ways. Rapid increase in population leads to decrease in capital labour ratio and thus lower labour productivity. On the other hand, higher population growth may also results in higher dependency ratio leaving less to be invested. All these together imply higher population growth inhibits economic growth.

Institutions in Place

We have explained the importance of institutions in place in the context of health production function. It also plays an important role in determining the economic condition of a nation. Political nature of a state influences its allocation decisions and policy formulation in different areas. For example social sector can flourish in presence of socialist or Marxist government. However, apart from the political institutions, different socio-economic organisations, like many NGOs, also play an important role in determining economic performance. As discussed in chapter 3, they help to promote social sector and sometimes influence government's economic policies which, in turn, contributes to the improvements in nation's economic condition.

4.2 The Econometric Model Specification

To test the above hypothesis we specify the following econometric models of estimation of growth function.

Growth function

$Gr_{it} = \hat{\alpha}_i + \beta' X_{it} + \varepsilon_{it}$, i=1,....,n; t=1,...,T, where

Gr_{it}: Growth rate of i^{th} state in period t.

X_{it}: Vector of determinants of growth in period 't'.

$\hat{\alpha}_i$: The individual effect for i^{th} state assumed to be constant over time.

ε_{it}: The stochastic error term.

4.3 Data and Variables

It might be appropriate to note at the outset that our study is a panel data analysis of Indian states over the time, 1998-2002. To estimate the econometric model of growth function we now describe the data and the variables.

4.3.1 Data

We have collected panel data for our estimation, namely data for Indian states over a period of time, 1998-2002. These are essentially secondary data, collected from the website www.indiastat.com. Like the previous chapter here also our study focuses on sixteen major Indian states, because only for these major states, consistent data for all variables over the entire panel period could be collected. There were a few missing data points in the data set and we generated them through statistical interpolation. For the other states (primarily from the north east) and union territories, there were large chunks of missing data points and hence we were constrained to exclude them from the study.

Data on net state domestic product at 19930-94 prices is collected from Indian Public Finance Statistics of ministry of Finance, government of India. School enrolments and literacy data are compiled and published by The Departments of Secondary and Higher Secondary Education and Elementary Education and Literacy of Ministry of Human Resource Development, Government of India.

Political institution related data are collected from Statistical Report of General Election, Election Commission of India, for different states in various years. Data on number of NGOs in different states are mainly compiled from the Lok Sabha and Rajya Sabha un-starred questions. State wise government plan revenue and capital expenditure data is published by Reserve Bank of India. Finally data on per capital expenditure on research and development (R & D) has been collected from the issues of Research and Development Statistics, Ministry of Science and technology, Government of India.

4.3.2 Variables

Growth Rates of income

It is the dependent variable of our growth function. We will estimate the impacts of different determinants, as described above, on economic growth (***Gr***). We first collected data on net state domestic products at constant prices (1993-94 prices) for the states over the years 1997 to 2002 and then calculated the growth rates for 1998 to 2002. These growth rates will be regressed over the explanatory variables. Among the explanatory variables we expect initial level of income of the states and population growth rate to have negative impact on growth. Others like education health and investment are likely to exert positive impacts on economic growth.

Initial Level of Income of States

As we have already mentioned our study is a panel data analysis for sixteen major Indian states. Net state domestic product at constant prices (1993- 94 price level) at the base year i.e. 1998 (***NSDP98***) is used as initial level of income of the states. According to the theories (Barro, 1991), initial level of NSDP will exert a negative impact on subsequent growth rates. This is because with a certain level of human capital (which is above the level typically accompanying low level of income) poor states are likely to grow faster than the richer states due to higher returns to human capital.

Human capital

As explained before, human capital has two components- knowledge and health status. These two together improve individuals' intellectual and physical capabilities two produce more. If productivity increases, output will also increase leading to a higher growth rate. Therefore, if a country has a higher stock of human capital, returns to labour will be higher and thus output will also be higher. For our purpose we have taken literacy rates (***Lt***) as the proxy for knowledge capital and inverse of infant mortality (***IMRINV***) rates as proxy to the health capital.

State of Technology

State of technology, knowledge or skill can not be measured directly because they do not have any quantitative volumes. Therefore, we encounter different difficulties to measure technology. Sometimes, diffusion rates, number of patents or intellectual property rights held by the nations etc, are considered as proxies of state of technology, but problems may arise regarding the availability of these data.

For our purpose, state level R & D expenditure is taken to describe the state of technologies of the states. The assumption is higher is the per capita expenditure for R & D development more will be the technical progress. Therefore, per capita R & D expenditure (***PCRD***) by the states can describe the state of technology of the states.

Investment-GDP Ratio

Due to non avail ability of investment data at state level we consider governments' plan expenditure as proxy for state level government investment. Now plan expenditure has two components, namely revenue expenditure and capital expenditure. We use both, ratio of revenue and capital expenditure to net state domestic product, for our study. The variables are denoted by ***REVSDP*** and ***CAPSDP*** respectively. Expenditure doesn't always have a negative impact on growth. If it is expenditure in social sectors like health and education then it could be growth stimulating as well. However, the ultimate effect depends on how and where government spends its money.

Population Growth

Population growth rate has important influence on economic performance. It reduces capital labour ratio leaving less capital for per unit of labour. This in turn reduces their productivity and thus output growth. On the other hand if population growth rate is high that may lead to higher dependency ratio and lower savings accumulation. Thus, investable surplus also decreases. Therefore we see a negative impact of high population growth on economic growth.

In our analysis we use total fertility (***FRT***) rates of the states for the consecutive five years (1998-2002) as a proxy for population growth rate. If the fertility rate is high then the impact will be negative.

Institutions in Place

Importance of institutional structure of the states has already been discussed. We consider two proxies of institutions, namely, party in power (***PTY***), which is a dummy variable and population served by the NGOs (***POPNGO***). Construction of Pty is as follows,

PTY= 1, when there is same party (or alliance) both at the centre and state

= 0, when there are different parties at centre and state.

Presence of same party, both at centre and state, can facilitate growth of that state, because central government may then favour theses states in terms of allocation of more resources and implementation of more favorable economic and social policies. This may not be the case when the parties are different at centre and state. For the other variable i.e. ***POPNGO,*** if the burden of population served per NGO increases then resources will be thinly spread among the citizens and quality of service by them will also decrease. Therefore, higher population burden per NGO can in fact reduce economic growth. If the number of NGOs increases then that will help to promote economic growth.

4.4 The Econometric Methodology

The model to be estimated can be described as follows,

$$Gr_{it} = \hat{\alpha}_i + \beta_1 NSDP98_{it} + \beta_2 FRT_{it} + \beta_3 Lt_{it} + \beta_4 IMRINV_{it} + \beta_5 POPNGO_{it} + \beta_6 PTY_{it} + \beta_7 REVSDP_{it} + \beta_8 CAPSDP_{it} + \beta_9 PCRD_{it} + \varepsilon_{it}$$

As stated above, we estimate the econometric model using panel data for 1998-2002 for 16 Indian states. The above model can be described by the following general panel regression model,

$$y_{it} = \alpha_i + B' X_{it} + \varepsilon_{it} \ldots (1)$$

Depending upon the assumptions made for α_i, the model can be analyzed under two different frameworks. These frameworks are referred to as ***fixed effects and random effects*** respectively. As have already discussed about the fixed effect and random effect model in chapter 3 under fixed effect model α_i s correlated with the explanatory variables and under random effect model α_i s are not correlated with the explanatory variables.

The decision regarding the application of fixed effect or random effect model can be decided on the basis of the results produced by the Hausman test.

Presence of ***multicollinearity*** can be detected by looking at pair wise correlation coefficient using Pearson's product correlation coefficients of explanatory variables for each pair of X variables. As stated also in the chapter 3 the test statistics is given by

$$t = [\rho\tilde{}(n-2)^{1/2}] / [1 - \rho\tilde{}]^{1/2}.$$

Under the null hypothesis, $\mathbf{H_0: r = 0}$ **against** $\mathbf{H_1: r \neq 0}$, the test is asymptotically distributed as 't' with (n-2) degrees of freedom. The test for multicollinearity does not show high correlation among each pair of the explanatory variable therefore we can use all the variables for the study.

Next step is to test for the presence of ***heteroscedasticity.*** White (1980) has proposed an alternative method to estimate the variance of β even if the form of disturbances is not known. This is known as ***robust estimation***[9].

4.5 Results and Interpretations

In this section we will present the result of our estimation and investigate the impact of different determinants on growth of the states. We have growth rates of sixteen major Indian states over the years, 1998-2002, as the dependent variable of

[9] Please see appendix A.4. for a note on Robust Estimation

our regression and nine explanatory variables representing initial level of income of the states, education status, health status, state of technology, public investment and institutions in place for the states. Analyzing the pair wise correlations of the explanatory variables we found none of the variables are highly correlated, excluding the possibility of multicollinearity. Hausman test[10] confirms that our model is a random effect model. The result our estimation is explained below.

Table: 4.1- Random-effect Regression of Gr on Explanatory Variable of the Model

Explanatory variables	Coefficient	z-values	p>|z|
NSDP98	-.0004264	-2.07	0.038**
FRT	-1.515474	-1.74	0.083*
Lt	-.2444671	-3.49	0.000***
IMRINV	94.9111	2.34	0.020**
POPNGO	-.0001504	-1.19	0.233
PTY	-.4367718	-0.35	0.724
REVSDP	.0004166	2.23	0.026**
CAPSDP	.2220034	0.69	0.493
PCRD	6.026233	1.99	0.047**
Constant	19.43547	3.20	0.001
R-sq (over all)	0.3197		
Wald χ^2 (10)	315.83		
Prob >χ^2	0.0000		
Number of observation	80		
Number of groups (states)	16		

*-10% level of significance, **- 5%level of significance, ***-1% level of significance.

Our empirical results by and large are supporting the economic theories. Now we will explain the results with appropriate explanations

Initial Level of Income of States

Our estimation shows that *NSDP98* exerts a significantly (at 5% level of significance) negative impact on the subsequent growth rates. Therefore, it confirms the convergence hypothesis of neoclassical growth models i.e. poor countries tend to grow faster than the large countries only for a given quantity of

[10] Please see appendix A.7 for Hausman test result of growth function.

human capital i.e. only if their human capital exceeds the amount that typically accompanies the low level of per capita income.

Human Capital

For our purpose, inverse of infant mortality rate (***IMRINV***) and literacy rates (***Lt***) of the states are used as proxies of the human capital. Higher infant mortality rate is associated with lower health status and thus expected to have a negative impact on the growth. However since we have considered inverse of infant mortality rate we expect it to have a positive impact on growth rates and our result confirms it. ***IMRINV*** appears to have a significantly (at 10% level of significance) positive impact on growth rate. Human Capital in terms of health boosts economic growth.

Second proxy of human capital that has been used here is the literacy rates (***Lt***) of the states. Result shows that ***Lt*** exerts a significantly negative impact on growth, which is very difficult to explain. The reason may be attributed to the discrepancies of data.

State of technology

For our purpose we have used sate wise per capita R & D expenditure as a proxy for the state of technology of the states. Here we found that that ***PCRD*** is significant (at 5% level of significance) and positively affecting the economic growth. Therefore, we may conclude that, as expenditure for research and development increases that will help to generate new ideas, technologies and products, contributing to knowledge creation. This in turn will positively affect countries output growth and thus facilitates economic growth.

Investment-GDP Ratio

Due to non availability of sate wise investment data we have taken two components of state wise plan government expenditure relative to their net GDP namely revenue expenditure and capital expenditure as proxy of government investment (***REVSDP, CAPSDP***). We found though capital expenditure does not have any significant impact on the economic growth, revenue expenditure is significantly and positively affecting the states' economic performance. The reason may be attributed to the fact that some part of revenue expenditure is being

spent in social sectors like health and education and therefore, a positive return in terms of higher economic growth can be obtained from the expenditure. Therefore, it can be concluded government expenditure in such sectors acts like investment expenditure and not as consumption expenditure.

Population Growth Rate

We have used total fertility rate (*FRT*) of the states as proxy of the population growth rate. Our result shows that *FRT* is negatively related to NSDP growth rate (*Gr*) and it is significant at 10% level. It supports our hypothesis that higher population growth rate inhibits economic growth. The reason is already explained above. Higher population growth reduces capital labour ratio and increases dependency ratio. As a consequent per capita availability of capital decreases affecting output growth negatively.

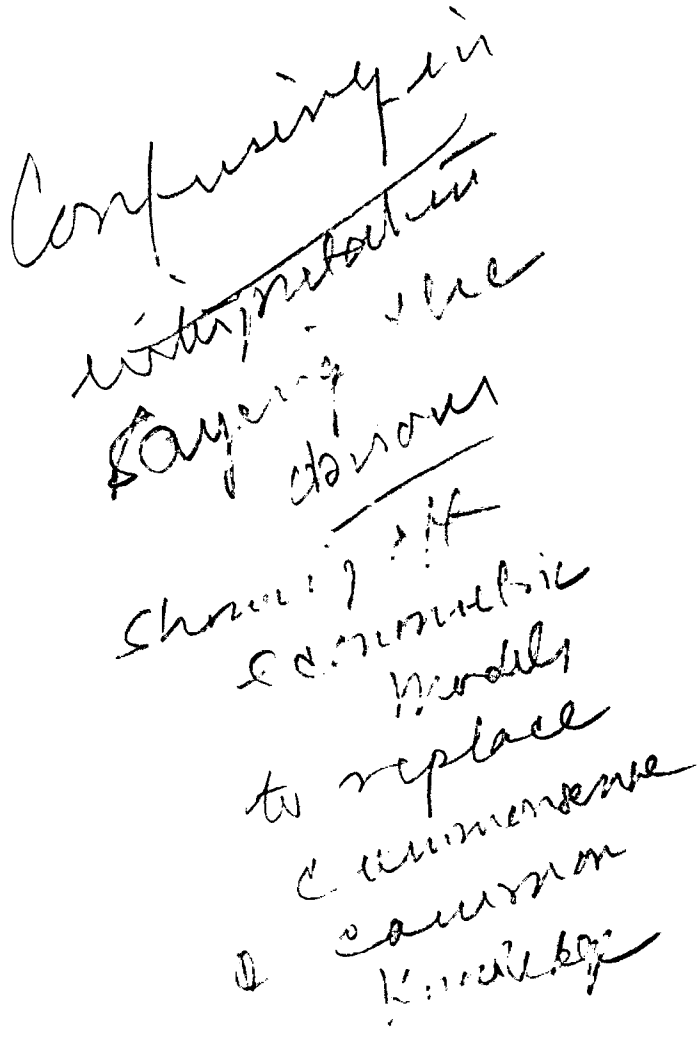
Institutions in Place

There are two proxies of institutions in place, *POPNGO* and *PTY*. None of these variables appeared to be significant in our study. Therefore, in our study institutions do not have any significant impact on economic growth directly. However, in chapter 3 we have seen that institutions in place have an indirect impact on the social sector like health. Therefore, one possible conjecture could be that though institutions do not exert any direct impact on economic performance it can facilitate economic growth by influencing sectors like health education etc.

4.6 Conclusion

In this chapter we have focused mainly on estimation of a growth function for sixteen major Indian states using panel data over a period of time, 1998 to 2002. Our growth equation is shaped by human capital, government investment, and technology conditions of the states, population growth and institutional structure of the respective states. We found significant impacts of health, technology, investment and population on economic growth. Since the main emphasis of the thesis is on health and we have obtained a significant and positive impact of health on economic growth, our result confirms the importance of health as a component of human capital and its impact on economic performance. Therefore, government

should provide more resources to the health sector so that apart from better health status of the citizens, returns could also be obtained in form of higher economic growth.



Chapter 5: Conclusion

The objective of this thesis is twofold. First of all, we have identified different socio-economic determinants of health status and then, incorporating them in a well-specified health production function we have tried to estimate their probable impacts on health status for sixteen major Indian states over the time, 1998-2002. Second, we have tried to test for the existence of positive impact of health on economic growth for the same. The research questions were addressed with the help of econometric models, using panel data for the years, 1998-2002 and also the analysis is supplemented by relative efficiency measurement for these states in production of health.

The conceptual foundation of the study begins with the theories of human capital where health, apart from education, is also recognized as the other factor, contributing significantly to human productivity. Using the same concept, in the latter phase, the endogenous growth theories incorporated human capital (health and education) in production function as the third factor of production (other than physical capital and labour) and estimated their impacts on economic growth.

However, endogenous growth theories consider health as an exogenously given input of production and no explanation has been provided for this assumption. But an in depth analysis of the issue will help us to understand that health is not a given input, rather it requires constant supply of different health inputs like health infrastructure, health expenditure etc. to achieve higher health status. The schematic diagram as described in chapter 1 helps us to understand the relationship between health outcomes and different health inputs. Therefore, in this context, we conceptualize a ***health production function*** which is essentially a mapping from health inputs to health outcome through a complex interplay of several factors depicted in the chapter 1. In our study we have tried to estimate a macro level health production function for India using panel data for sixteen major Indian states.

In our econometric analysis of health production function we found that the function is shaped by different health related inputs like education (literacy rates, secondary and higher secondary enrolments of the states), health infrastructure (population served by the hospitals, primary, community and sub centre length of road per 100 sq kilometres), institutions in place (party in power both at state and centre and, per capita number of NGOs), per capita health expenditure and state level income. These inputs directly or indirectly can affect health status of the citizens.

As depicted in chapter 3, there are two endogenous variables in our econometric model of health production function-(1) health expenditure and (2) health outcome. First we estimated the health expenditure function, determined by exogenous variables like lagged per capita state level GDP, educational status of the citizens and intitutions in place and then given the health expenditure function we estimate the health outcome function which is typically determined by one endogenous variable (i.e., health expenditure) and other exogenous variables namely health infrastructure, education and institutions in place. These two functions together forms our estimated health production function and the model structure described in this context is recursive with two structural equations.

By and large our econometric findings are in consonance with the theoretical predictions. We found that literacy rates, per capita number of NGOs and per capita income of the states have significantly positive impact on per capita health expenditure by government. It can be therefore concluded that if the educational status of the states increases then people will become more aware of their health condition and demand for greater medical services will increase, forcing the government to invest more in health sector. Second, higher state level income enables the states to invest more in the health sector after meeting their basic necessities. Finally, social institutions, with powerful civil society networks, captured by number of per capita NGOs, also play an important role in determination of health expenditure of the states. They sometimes act like pressure groups that create social pressure on the government to adopt policies and decisions which, in turn, can influence health expenditure decision of the government positively.

Turning to health outcome function we found health expenditure, higher education and road to have significant and positive impact on health outcome, which in turn confirms that if the state governments tend to spend more in the health sector facilitating better health infrastructure, then that will help higher health attainments. Similarly higher educational status of the citizen influences their health behaviour by creating more awareness which can positively affect their health outcome. Among the other determinants we found population served by the hospitals is exerting a significantly negative impact on health which explains if population burden per hospitals increases then efficiency of the hospitals will fall. In other words, greater health infrastructure improves health status.

The analysis of health production function is supplemented by data envelopment analysis which sought to estimate relative efficiencies of different states in utilizing health inputs taking health outcome as given. However, we did not find much inter-state variation in this regard. Therefore, we concluded that poor health outcomes of some of the states, therefore, is not essentially due to relative inefficiency of resource utilization but perhaps due to lack of adequate resources and infrastructure.

Chapter 4 mainly focuses on contribution of health to economic performance. In this context again our emphasis is on the endogenous growth theories. One prediction of the endogenous growth theories is that apart from physical capital, human capital also, namely health and education, can significantly affect pace of growth of any economy. In chapter 4 we have tried to investigate this issue with special emphasis on health.

In our econometric model growth is determined by several variables like states' initial level of income, human capital variables-education (literacy rate) and health (infant mortality rate), state of technology of the states (per capita R & D expenditure), government investment relative to the net state domestic product (plan revenue and capital expenditure), population growth (fertility rate) and institutions in place (party in power and population served by the NGOs).

Our result suggests that, fertility rate, infant mortality rate, per capita R & D expenditure, revenue expenditure of the government and initial level of income of the states are important in determination of pace of economic growth. The idea is higher population growth rate leads to lower capital labour ratio and higher dependency ratio, resulting in lower inevestable surplus and thus inhibiting the pace of growth. Conversely, investment in new technology (knowledge) generation (per capita R & D expenditure) or social sectors like education and health facilitates human capital accumulation and thus promotes higher economic growth. However, once a certain level of human capital is reached then poor states tend to grow faster than the richer states and gradually the growth rates will converge to the steady level. Therefore, we see initial level of SDP is negatively related to economic growth.

To conclude, in our study, we have attempted to analyse the role of health in India's economic development. Unlike most other conventional studies that focus only on health expenditure as the key determinant of economic growth, in our study we have made a distinction between health inputs and health outcomes. We have shown how health inputs (not only health expenditure but also other variables like infrastructure, education, institutions etc) shape health outcomes, which in turn determines economic performance. The results of our econometric analysis are, by and large, in line with *a-priori* theoretical expectations. Our study clearly highlights the important role played by health in India's economic development.

Appendices

A.1. Note on Principal Component Method

Since we have a large number of indicators, we need a method to arrive a composite index, incorporating all of them. Keeping all theoretical and practical problems in mind, we use the Principal Component Method (PCM) to arrive at a latent variable to capture a particular variable in all its dimensions. This method was first introduced by *Nagar & Basu,* (2002) and is summarized below.
We have ***n*** observations on ***k*** variables which is represented by **X**, where

$$X = \begin{bmatrix} x_{11} & \cdots & x_{k1} \\ \cdots & \cdots & \cdots \\ x_{n1} & \cdots & x_{kn} \end{bmatrix}$$

We transform the **X**'s to a new set of ***k*** variables (say **Z**) which will be pair wise uncorrelated and of which the first will have the maximum possible variance.

$$\text{Let } z_1 = X a_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

denote the first new variable, where $\mathbf{z_1}$ is an ***n***-element vector and $\mathbf{a_1}$ a ***k***- element vector. The sum of square of $\mathbf{z_1}$ is

$$z_1' z_1 = a_1' X' X a_1 \ldots\ldots\ldots\text{(ii)}$$

Now to maximize $z_1' z_1 = a_1' X' X a_1$ we are imposing constraint $a_1' a_1 = 1$, otherwise $z_1' z_1$ could be made indefinitely large.

Therefore our problem is $\varphi = a_1' X_1' X a_1 - \lambda_1(a_1' a_1 - 1) \ldots\ldots\ldots\text{(iii)}$

where λ is the Lagrange Multiplier.

Maximization of this problem gives $(X' X)a_1 = \lambda_1 a_1 \ldots\ldots\ldots\ldots\text{(iv)}$

Thus $\mathbf{a_1}$ is a latent vector of corresponding to the root λ_1.

Hence we can write, $z_1' z_1 = a_1' X' X a_1 = \lambda_1 a_1' a_1 = \lambda_1$, since $a_1' a_1 = 1$. So we must choose λ_1 as the largest latent root of X'X. The first principal component of X is therefore, Z_1.

Now we have to obtain second new variable $z_2 = X a_2$. Therefore now our problem is

max $a_2' X' X a_2$, subject to $a_2' a_2 = 1$ and $a_1' a_2 = 0$ (*since z_2 is uncorrelated with z_1*).

Now the covariation between them is given by

$$a_1' X' X a_2 = \lambda_1 a_1' a_2$$
$$= 0 \text{ } \textit{iff} \text{ } a_1' a_2 = 0$$

Therefore now our problem is $\varphi = a_2' X' X a_2 - \lambda_2(a_2' a_2 - 1) - \mu(a_1' a_2)$, where λ, μ are Lagrange multiplier. Maximization of this problem gives $(X' X)a_2 = \lambda_2 a_2$ and λ_2 should obviously be chosen as the second largest latent roots of $X' X$. If we repeat the same procedure for each of the k roots of $X' X$, we will get the k pricipal components of X such that $\lambda_1 > \lambda_2 > .... > \lambda_k$ and assembling the resultant vector we have orthogonal matrix $\mathbf{A} = [\mathbf{a_1} \quad \mathbf{a_2} \quad \ldots \quad \mathbf{a_k}]$. The Principal Components of **X** are then given by the n x k matrix $\mathbf{Z} = \mathbf{XA}$.

Moreover $Z' Z = A' X' X A = \Delta = \begin{bmatrix} \lambda_1 & 0 & \ldots & 0 \\ 0 & \lambda_2 & \ldots & 0 \\ \ldots & \ldots & \ldots & \ldots \\ 0 & 0 & \ldots & \lambda_k \end{bmatrix}$

which shows that the Principal components are pairwise uncorrelated and that their variances are given by $z_i' z_i = \lambda_i$ where $i = 1, 2, ...k$.

If the rank od X is r<k, (k-r) roots would be zero and the variation of the X's could be completely expressed in terms of r independent variales. even if x has full column rank, some of λs could be fairly close to zero. therefpre, that small number of principal cpmponet accopunt for a substantial proportion of the varition of X's. The total variation in the X is given by

$$\sum_t x_{1t}^2 + \sum_t x_{2t}^2 + \ldots\ldots\ldots + \sum_t x_{kt}^2 = \text{tr}\,(X' X)$$
$$= \sum_{i=1}^{k} \sum_{t=1}^{n} x_{it}^2$$
$$= \sum_{i=1}^{k} \lambda_i$$
$$= z_1' z_1 + \ldots\ldots\ldots\ldots\ldots z_k' z_k$$

Thus $\frac{\lambda_1}{\sum\lambda}, \frac{\lambda_2}{\sum\lambda}, \ldots\ldots\ldots\ldots \frac{\lambda_k}{\sum\lambda}$ represents the proportionate contributions of each Principal Component to the total variation of X's, and since the components are orthogonal these contributions sum to unity. By taking a weighted average of all

the principal components, we can arrive at a composite index Z that captures the entire variation in all the X-s:

$$Z = \frac{\lambda_1}{\sum\lambda} Z_1 + \frac{\lambda_2}{\sum\lambda} Z_2 + \ldots\ldots\ldots + \frac{\lambda_k}{\sum\lambda} Z_k$$

A.2. Note on Recursive Model

General form of linear simultaneous equation model, known as structural model, can be written as,

$$[y_1 \;\; y_2 \;\; .. \;\; y_M]_t \begin{bmatrix} \gamma_{11} & \gamma_{12} & .. & \gamma_{1M} \\ \gamma_{21} & \gamma_{22} & .. & \gamma_{1M} \\ .. & .. & .. & .. \\ \gamma_{M1} & \gamma_{M2} & .. & \gamma_{1M} \end{bmatrix} + [x_1 \;\; x_2 \;\; .. \;\; x_k]_t \begin{bmatrix} \beta_{11} & \beta_{12} & .. & \beta_{1M} \\ \beta_{21} & \beta_{22} & .. & \beta_{2M} \\ .. & .. & .. & .. \\ \beta_{k1} & \beta_{k2} & .. & \beta_{kM} \end{bmatrix} = [\varepsilon_1 \;\; \varepsilon_2 \;\; .. \;\; \varepsilon_M]_t$$

Or, $\mathbf{Y_t'\Gamma + X'_tB = \varepsilon'_t}$

There are M equation and M endogenous variables, denoted by $y_1,\ldots,y_M$. There are K exogenous variables,, $x_1, \ldots\ldots,x_k$. ε s are the structural disturbances. The subscript t will be used to index observations, t=1,...,T. each column of the parameter matrices is the vector of coefficients in a particular equation, where as each row applies to a specific variable. One of the variables in each equation is the dependent variable so then its coefficient will be 1. Thus there will be at least one 1 in each column of Γ. This is called the normalization. The relationship defined for given equation will remain unchanged if multiplied by same constant. Choosing a 'dependent variable' will remove the indeterminacy. If there any identities then corresponding columns of Γ, B will be know and there will be no disturbance for the equation. Since all variables do not appear in all equations, some of the parameters will be zero. There can be some other kind of restrictions also. If Γ is an upper triangular matrix, then the system is said to be triangular. Model is given by,

$$y_{t1} = f_1(X_t) + \varepsilon_{t1}$$
$$y_{t2} = f_2(y_{t1}, X_t) + \varepsilon_{t2}$$

$$y_{tM} = f_M(y_{t1}, y_{t2}, y_{t3}, \ldots\ldots, y_{t,M-1}, X_t) + \varepsilon_{tM}$$

A.3 Note on Hausman Specification Test

The specification test devised by Hausman (1978) is used to test for orthogonality of random effects and regressors. The test is based on the idea that under the

hypothesis of no correlation, both OLS and GLS are consistent, but OLS is inefficient, where as under the alternative, OLS is consistent but GLS is not. Therefore, under null hypothesis, the two estimates should not differ systematically and test can be based on difference. Other essential part of the test is the covariance of the difference,

$$\left(b-\hat{\beta}\right): Var\left(b-\hat{\beta}\right)=Var(b)+Var\left(\hat{\beta}\right)-Cov\left(b,\hat{\beta}\right)-Cov\left(b,\hat{\beta}\right).....(1)$$

Hausman's essential results is that the covariance of an efficient estimator with its difference from an inefficient estimator is zero, which implies that

$$Cov\left[\left(b-\hat{\beta}\right),\hat{\beta}\right]=Cov\left(b-\hat{\beta}\right)-Var\left(\hat{\beta}\right)=0$$

$$Cov\left(b,\hat{\beta}\right)=Var\left(\hat{\beta}\right)$$

Inserting this result into (1) we get,

$$Var\left(b-\hat{\beta}\right)=Var(b)-Var\left(\hat{\beta}\right)=\psi.....(2)$$

The Chi-Square test is based on Wald criterion:

$$W=\chi^2(K-1)=\left(b-\hat{\beta}\right)\hat{\psi}^{-1}\left(b-\hat{\beta}\right)$$

For $\hat{\psi}$ we use estimated covariance matrix for the random effect model excluding the constant term. (Green, 2003)

A.4. Note on Robust Estimation

If X is the set of stochastic variables and the variance covariance matrix of the error term is given by $\sigma^2\Omega$ then the covariance matrix of the OLS estimate β is given by

$(X'X)^{-1}[X'(\sigma^2\Omega)X](X'X)^{-1}$.

Now the attempt is not to estimate $[X'(\sigma^2\Omega)X]$, but to construct a matrix form the sample that will behave like this matrix. Since β= $(X'X)^{-1}$ X'y, where y is the matrix of dependent variables the matrix $[X'(\sigma^2\Omega)X]$ can be written as variance of X'y. Now if y is an n×1 vector and x is n×k vector then, X'y is k×1 vector, whose variance is,

$V(X'y)=\sum u_j^2(X_jX_j)$

Where X_j is a row vector of order 1×k, then product term in the bracket in RHS is k×k matrix. Then the robust estimator of OLS boils down to

$$V(\beta)=(X'X)^{-1}(\sum_{j=1}^{n}u_j^2x_j^Tx_j)(X^TX)^{-1}$$

This is the variance covariance matrix of the Robust estimator And therefore, we can get the correct values of t statistics.

A.5 Result of Hausman Test for Health Expenditure Function Estimation

Explanatory variables	Coefficients (fe). b	Coefficients (re).	(b- β) Difference	sqrt(diag(V_b-V_B)) S.E.
LT	2.853206	3.57943	-.7262242	.3317517
Enrsc	-.0000206	-.0000342	.0000136	.0000173
Enrhs	5.38e-06	-4.01e-06	9.39e-06	8.90e-06
PCNSDP	.0106257	.010584	.0000418	.0014035
PTY	1.281625	9.268983	-7.987358	-7.987358
PCNGO	140234	107359.9	32874.08	31073.93

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)=1.21
Prob>chi2 = 0.5471

A.6 Result of Hausman Test for Health Outcome Function Estimation.

Explanatory variables	Coefficients (fe). b	Coefficients (re). β	(b- β) Difference	sqrt(diag(V_b-V_B)) S.E.
HE	.0018839	.0015068	.0003771	.0009944
ROAD	-.001693	.0045554	-.0062484	.0031515
POPHOSP	1.62e-07	-6.09e-07	7.71e-07	5.59e-07
HC	1.62e-07	-.0286047	.0021975	.0471844
PCNGO	1.62e-07	-.1240774	.3680244	.2150386
PTY	-882.526	133.3493	-1015.876	528.4038
Enrsc	1.16e-07	1.26e-07	-1.00e-08	2.35e-07
Enrhs	1.80e-07	1.15e-07	6.53e-08	1.77e-07

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)= 4.74
Prob>chi2 = 0.0933

A.7 *Result of Hausman Test for Growth Function Estimation*

	Coefficients (fe) (b)	Coefficients (re) (B)	(b-B)	sqrt(diag(V_b-V_B)) S.E.
sPCRD	-12.06594	6.026233	-18.09217	16.08533
FRT	-11.12026	-1.515474	-9.604781	9.023038
POPNGO	-.0002637	-.0001504	-.0001133	.0000886
PTY	2.521726	-.4367718	2.958498	2.795577
Lt	-.3935505	-.2444671	-.1490834	.0897603
IMRINV	-154.61	94.9111	-249.5211	160.8809
REVSDP	.0004215	.0004166	4.94e-06	.0001299
CAPSDP	.8971393	.2220034	.6751359	.393585

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)= 11.18
Prob>chi2 = 0.0828

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