A CGE Approach To Modeling Health

Submitted By:
Nitesh Sahay
Introduction

The Constitution of India envisages the establishment of a new social order based on equality, freedom and justice by aiming to eliminate poverty, ignorance and ill-health. The State regards the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties, securing the health and strength of workers, men and women, specially ensuring that children are given opportunities and facilities to develop in a healthy manner. However, when looking at some of the development indicators, we find that a lot remains to be done. For example, the following table shows the comparative position of India vis-à-vis some other Asian countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>1960</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>28</td>
<td>52(^1)</td>
</tr>
<tr>
<td>South Korea</td>
<td>71</td>
<td>97</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Thailand</td>
<td>68</td>
<td>94</td>
</tr>
</tbody>
</table>


Even within India, we find tremendous disparities in these indicators.

\(^1\) Note: Age 7+, 1991
Table 2: Health Indicators

<table>
<thead>
<tr>
<th></th>
<th>Life Expectancy</th>
<th>Infant Mortality Rate</th>
<th>Female – Male Ratio</th>
<th>Total Fertility Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>59</td>
<td>59</td>
<td>80</td>
<td>0.93</td>
</tr>
<tr>
<td>China</td>
<td>68</td>
<td>71</td>
<td>31</td>
<td>0.94</td>
</tr>
<tr>
<td>Kerala</td>
<td>69</td>
<td>74</td>
<td>17</td>
<td>1.04</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>57</td>
<td>55</td>
<td>98</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Source: Dreze and Sen (1995), Statistical Appendix

In the words of Ministry of Health (Government of India), “The high rate of population growth continues to have an adverse effect on the health of our people and the quality of their lives. The mortality rates for women and children are still distressingly high; almost one third of the total deaths occur among children below the age of 5 years; infant mortality is around 129 per thousand live births. Efforts at raising the nutritional levels of our people have still to bear fruit and the extent and severity of malnutrition continues to be exceptionally high. Communicable and non-communicable diseases have still to be brought under effective control and eradicated. Blindness, Leprosy and T.B. continue to have a high incidence. Only 31 percent of the rural population has access to potable water supply and 0.5 percent enjoys basic sanitation.”

Sukhatme points out that an appreciable proportion of the population in India lacks sufficient amount of protein in diet. On the productivity side, it has been shown that annual productivity loss in India occurring due to malnutrition is as high as US $ 10 billion. It also points out that there are 400 million

---

2 http://mohfw.nic.in/95/ii/95iii0101.htm
3 Sukhatme (1972)
Indians who cannot afford medical care and that cost of medical care is the second most common cause of rural indebtedness⁴. While these figures do raise serious doubts over the efforts made by the Indian state to combat problems of poor public health and low levels of development, one should not undermine the resources devoted towards these issues right from the time of independence. Based on models describing a ‘low-level equilibrium trap’⁵ in which population growth became a constraint on the growth of per capita income and thus other development indicators, and Malthusian idea of population being an independent variable and other things at most acting as a positive check on population growth once it reaches unsustainably high levels (both in terms of actual levels and the rate of increase), we find efforts being put right from early 1950s to bring India out of this ‘trap’. Qadeer⁶ points out that after 1949, a conscious effort was made to invest in education and health services. Health services were considered as the responsibility of the provincial states. The role of central government was to define policies, provide a national strategic framework, financial resources and specified services such as services for people crossing international borders and medical education. Rao (1994), in fact states that India was one of the first nations in the world to initiate an official family planning program. He describes the Indian experience with health experiment which relied primarily on controlling the population growth as follows:

Commencing in the First Five Year Plan in 1952, with a clinic approach, the program took wing in the Third Five Year Plan with the adoption of the Extension Education approach in 1962. In 1965, the United Nations Advisory Mission suggested the launching of what was called the ‘Reinforced Program’, the major component of which was an “energetic loop (IUCD) program”. As a consequence, the program was overhauled with an emphasis on the intra-uterine device to meet the family planning program goals. Towards the end of the 60s it was increasingly being realized that the IUCD strategy had not been successful. The program strategy in the Fourth Plan period, in the early 1970s, relied therefore largely on vasectomy in what was called the ‘camp approach’. The camp approach, however, proved difficult to sustain and in view

---

⁵ Rao (1994): American economists during the period of 1950s, emphasized the role of capital accumulation in the development process. Underdevelopment was a condition of little capital stock in the workforce; development was the process of adding to that stock. It was argued that rapid population growth induced high dependency ratios in a country. This increased the need for investments in social sectors such as education and health, and thereby curtailed the capital available for more direct productive investments. A high dependency ratio also cut into the savings rate of the economy. The country was thus caught in a vicious cycle of poverty – high population growth rates – low savings – low productivity – poverty.  
⁶ Qadeer (1)
of the abuses in the family planning program in the period of the emergency, vasectomy was virtually abandoned. Attention now focused on female sterilizations – which formed the cornerstone of the program during the Sixth and Seventh Plan periods.

Towards the end of the Seventh Five Year Plan, it was increasingly, albeit grudgingly, being accepted that the program had failed. The mid-term appraisal of the Seventh Plan noted that the birth rate had not fallen despite the couple protection rates having gone up considerably. The Public Accounts Committee in its 139th Report observed that despite massive financial inputs into the program, the birth rate had remained stationary.

In fact the failure of the Indian state to significantly raise the health status of its people despite massive investments raises some critical issues about the approach being adapted. These issues can be divided into two separate questions:

1. How important is general health status of people in an economy?
2. How can health status of the people in general be improved?

While the first question has been examined in detail and has generally been agreed upon by many economists and social scientists world over, the second question has remained more controversial. In the next section, we do a rather brief literature survey of the issues involved.
Literature Survey

On the first question, a significant amount of work has been done to argue in favor of increase in health status of individuals. There have been many approaches to measuring the importance of health of an individual, and public health in general. While all these approaches involve a cost-benefit analysis, the difference emerges slowly with the passage of time, when we look at the measurement of benefits from improved health status.

In the earliest models, human being was mostly defined as capital and good health would be likened to more capital leading to higher returns. Therefore, the basic argument resided over the method used to find the capitalized value of human being, and the changes taking place in this value with change in health condition. Thus, one of the fundamental motives behind this approach was to show that “action against disease and illiteracy….will make a major contribution to economic growth”\(^7\). A history of this approach has been given briefly in Kiker(1966). Kiker points out several reasons for treating human beings as capital, some of them being: (1) to demonstrate the power of a nation; (2) to determine the economic effects of education, health investment and migration; (3) to propose tax schemes believed to be more equitable than the existing ones; (4) to determine the total cost of war; (5) to awaken the public to the need for life and health conservation and the significance of the economic life of an individual to his family and his country; and (6) to aid courts and compensation boards in making fair decisions in cases dealing with compensation for personal injury and death. There have been basically two methods to evaluate the value of the capital known as “human being”: the cost-of-production method, and the capitalized-earnings methods. The former looked at the real cost (net of maintenance) incurred in producing a human being and the latter at the present value of an individual’s future income stream. The first truly scientific procedure and the one followed today by many economists and others for finding the money value of a human being was devised in 1853 by William Farr. He suggested that since human beings are productive they should be regarded and taxed as capital. He

---

\(^7\) Mushkin (1962)
advocated the substitution for the existing English income tax system of a property tax that included property consisting of the capitalized value of earning capacity. His procedure for estimating the latter was to calculate the present value of an individual’s net future earnings (future earnings minus personal living expenses), allowance being made for deaths in accordance with a life table. 30 years later, Ernst Engel came up with a formula to estimate the money value of human being by using the cost-of-production approach. He argued that since yield value of certain human beings (for example, a Goethe or a Newton) could not be determined, a more real picture could be captured by looking at the cost of rearing of people to their parents. This he believed was real cost and could be used to measure the monetary value of society. His formula can be described as follows:

\[C_x = c_0 \left[1 + x + k\left[\frac{x(x+1)}{2}\right]\right]\]

where,

\(C_x\) = Total cost of producing a human being (neglecting interest, depreciation and maintenance) through age \(x\).

\(c_0\) = This denotes cost incurred up to the point of birth.

\(k\) = Annual percentage increase in cost.

In the meanwhile, a rather more involved formula was devised by Theodor Wittstein in 1867 who used a variation of both Farr’s capitalized-earnings and Engel’s cost-of-production approaches. Trying to arrive at a concept of human capital which could serve as a guide to be used as a basis for claims for compensation from loss of life, he assumed that an individual’s lifetime earnings are equal to his lifetime maintenance cost plus education. His equation can be given as follows:

\[C_{(a)} = \alpha R_{(0)} \frac{L_{(0)}^{(a)}}{L^{(a)}}r^n - \alpha R_{(a)}\]
\[ C_{(a)} = XR^{(N)}_{(n)} \frac{L^{(N)}_{(n)}}{L_{(n)}} p^{N-n} - \alpha R_{(n)}, \]

where \( \alpha \) is annual consumption expenditures including education for an average German male in a particular occupation; \( r = 1 + i \), where \( i \) is the market interest rate; \( p = 1/r \); \( L_{(n)} \) is the number of men living at age \( n \) in a life table; \( R_{(n)} \) is the value at age \( n \) of a 1-thaler annuity (for a given \( r \) and purchased at birth); \( X \) is the value of the future output of an average person in a particular occupation.; \( N \) is the age at which this man enters the labor force. Wittstein assumed for simplicity that \( \alpha \) and \( X \) are constant over the lifetime of an individual. He asserted, moreover, that the former equation (which is based on past values) for valuing a human being in money terms should be used when \( N > n \) but that when \( N < n \) the latter equation (which is based upon expected values) could be utilized more easily.

In 1930, a major contribution to measuring human capital, which also became the foundation for many of the future researches, was done by Louis I Dublin and Alfred J Lotka\(^8\). Being in life insurance business, they found it important to calculate the value of human being in ascertaining his life-insurance. Such calculations could also prove useful in estimating the economic costs of preventable disease and premature deaths. The result of their calculation was the formula:

\[ V_0 = \sum_{x=0}^{\infty} v^x P_x (y_x E_x - c_x), \]

where \( V_0 \) is the value of the individual at birth; \( v^x = (1+i)^{-x} \) is the present value of $1.00 due \( x \) years later; \( P_x \) is the probability at birth of an individual living to the age \( x \); \( y_x \) is yearly earnings per individual from age \( x \) to \( x+1 \); \( c_x \) is the cost of living for an individual from age \( x \) to \( x+1 \). While this method of capitalizing an individual’s earnings, minus his consumption or maintenance, gives a useful estimate for certain

\(^8\) Dublin and Lotka (1930)
purposes (for example, the economic value of the man to his family), a considerable question remained over the value of a human being to himself or to society. For these purposes, Dublin and Lotka came up with the capitalized-gross-earnings approach. The cost of producing an individual, $C$, up to age $a$, according to the new method would be:

$$\tilde{C}_a = \frac{1}{P_a} \left[ \sum_{x=0}^{a-1} v^{x-a} P_a (c_x - y_x E_x) \right],$$

which may be simplified to

$$C_a = V_a - \frac{1}{P_a v^a} V_0.$$

Hence, the cost of producing an individual up to age $a$ is equal to the difference between his value at age $a$ and his value at birth, multiplied by $(1 + i)^a / P_a$. The works of Farr and Dublin and Lotka form the basis of any future estimation of human-capital values. On explaining the cost side of poor health, Rimlinger\(^9\) reasons that development in health has not just been to increase productivity but has partly been in response to it. He argues that the development of modern health and welfare programs is at least in part a response to the rising productivity and increasing scarcity of labor in the course of economic development. While he agrees that some level of economic protection by the community is necessary in any civilized society, he points out that so long as labor is cheap and generally unskilled, this protection tends to be minimal and of a disciplinary nature. On the other hand, in highly developed economies welfare programs take on the character of investments in human capital. With advancing economic development and the implied rise in the average productivity and relative scarcity of labor, forms and levels of investment in human capital that were unprofitable under less-developed conditions, become more profitable. The higher the average productivity of labor, the more profitable it becomes to extend the effective working life span of the worker and to keep him fully employed. Thus, he states that to the extent that health and welfare programs upgrade and

\(^9\) Rimlinger (1966)
conserve the productive capacity of the work force and through countercyclical effects help to keep it employed, they are a rational institutional adjustment to the relative scarcities created by economic development.

In his book, *Economics of Public Health*, Weisbrod\(^\text{10}\) added a new dimension to the measurement of benefits from improved health in the form of reduced mortality and morbidity. For this he elaborates upon the monetary losses which society sustains as a result of poor health. This losses can summed up in the following points.

1. The first and the most obvious source of economic loss is premature death, with consequent loss of production.
2. A second economic consequence of disease is sickness, with the loss of production (partial or complete inability to work) which it may occasion.
3. The fact that a person has survived after a case of some disease does not necessarily mean that the total economic costs associated with the disease have already been realized. The illness may have reduced the individual’s resistance to other causes of disability, his/her future productivity, or both.
4. Temporary absence from work resulting from illness may necessitate certain adjustments of the production process which make the total cost of sickness greater than the cost to the individual worker. In an economy of widespread specialization and division of labor, the absence of one key worker may drastically reduce the productivity of others.
5. Poor health affects the size and composition (with respect to age, sex, geographic distribution, etc.) of the population through effects on mortality. Economic effects of a disease which affects children may differ substantially from those of a disease which primarily affects persons of middle or old age. Such matters as the effect on per capita income of variation of the ratio of workers to total population and of change in the size of the labor force are relevant.

\(^\text{10}\) Weisbrod (1961).
Weisbrod calls these five forms of poor-health costs as, at least in short-run, inevitable forms of costs. Apart from these, he points out, there are certain other kinds of costs that the society may choose to incur in an attempt to reduce the magnitude of these inevitable forms of costs. These he mentions as follows:

6. A disease may entail costs of detection, treatment, and rehabilitation of patients.
7. The existence of diseases may involve people in costly attempts to avoid the diseases. For example, the additional cost of filter-tip cigarettes is an “avoidance” cost attributable to lung cancer. Even though ineffective at times, such attempts represent a use of resources which would not occur except for the health hazard.

In a similar vein, Meeker\textsuperscript{11} computes the rate of return on public health investments and argues that these can be several times the return on alternative investments. He points out that the period 1880-1910 saw great improvement in the health of city dwellers. Life expectancy at birth for males in Boston rose from 37 in 1880 to 46 in 1910; in New York City it rose from 29 in 1880 to 45 in 1910. It has been shown that these improvements in the state of health came largely from a decline in the incidence of infectious disease and that most of this decline is fairly attributable to improvements in the standard of living-especially as reflected in diets and housing- and, for cities, to new public health measures especially the installation of sanitary sewers and the provision of central supplies of pure drinking water. For example, during the thirty-year period 1880-1910 there a rapid increase was witnessed in the fraction of the urban population served by sanitary sewers and improved water systems; in 1875 fewer than 30,000 urban citizens were supplied with filtered water; by 1910 the figure had risen to over 10,000,000. That the improved health resulting from these public health measures must have been regarded by its recipients as an increase in their well being is clear. Meeker shows that the social rates of return on the cumulated investments in public health projects may have exceeded the market rate of return on capital by several times. For this purpose he calculates two benefits from improved health measured here are (1) the dollar value placed on the reduction in work time lost stemming from the reduced incidence of certain diseases, and

\textsuperscript{11} Meeker (1974).
(2) the dollar value placed on increased life expectancy. The increments to life expectancy are evaluated in two ways. The first uses income per capita to estimate the present value of the utility derived from additions to life expectancy; the second uses the average annual wage, along with data on labor force participation rates, to estimate the present value of the additional expected lifetime output resulting from additions to workers’ life expectancies. He also measures the costs of providing public health during each of the thirty years are estimated. The capital costs estimate is calculated as the installation costs of sewers and water filtration plants. Finally, he estimates the rates of return on the cumulated investment in health-related projects over the period 1880-1910 using the benefits and costs estimated. Further he also makes an attempt to adjust the benefits so as to net out the dollar value of all health improvements not attributable to public health. The social rates of return to public health are then again recomputed using the adjusted benefit estimates and shown to be comfortably above the market rate of return. Meeker also assures that because the costs are estimated to give upper bounds, and because some of the benefits to improved health must go unmeasured, the adjusted rates of return are a lower bound estimate of the actual social rate of return to public health.

While in the earlier period, health was often clubbed together with other forms of human capital like education etc. (at least theoretically), we gradually find more significance being given to health as such, in terms of cost-benefit analysis for various health programs. While, Mushkin\textsuperscript{12} in his 1962 paper in \textit{The Journal of Political Economy} adhered to the same approach in terms of valuing human capital, he distinguished between health as a form of human capital and other forms of human capital (basically education) for various reasons. Firstly, he argues that health programs increase the numbers in the work force as well as the quality of labor force while education chiefly affects the quality of producers. Secondly, he points out that the two have to be measured differently. More precisely, units of quality change through human capital formation by health programs cannot be defined as tidily as units of education embodied in the labor force. For example, there is no quality unit comparable to that of the number of years of

\textsuperscript{12} Mushkin (1962)
schooling, devised by Schultz as a measure of educational stock in the labor force. Further, he points out that closely related to the problem of measuring quality changes attributable to health programs is the question of assessing earning differences. In assessing the private return to education, one begins with data on differentials in earnings according to years of education, while at that time there did not exist any particular index of differences in income associated with gradations in health. Finally, he notes that educational investment is a developmental process, which ferrets out and encourages native talent. It proceeds step by step from one level to another, transmitting a cultural environment by building on the existing store of knowledge. Health programs, on the other hand, seek basically to prevent a hostile environment from killing and crippling.

A rather significant change in measurement of the importance of health came with the view that it is not just a source of productivity increase but also a utility enhancing consumption good. One of the pioneers in formulating this approach is Michael Grossman. According to traditional human capital theory as discussed above, the value of human being is measured primarily in the form of the potential contribution he/she is capable of making to the society in general and his/her family in particular. It is argued that increases in a person’s stock of knowledge or human capital (in the form of good health etc.) raise his productivity in the market sector of the economy, where he produces money earnings, and in the non-market or household sector, where he produces commodities that enter his utility function. To realize potential gains in productivity, individuals have an incentive to invest in formal schooling and on-the-job training. The costs of these investments include direct outlays on market goods and the opportunity cost of the time that must be withdrawn from competing uses. This framework was used by Becker (1967) and by Ben-Porath (1967) to develop models that determine the optimal quantity of investment in human capital at any age. In addition, these models show how the optimal quantity varies over the life cycle of an individual and among individuals of the same age. Grossman goes beyond the argument that increases in stock of health would simply increase the wage rates. He argues that a person’s stock of

---

14 Grossman (1972)
knowledge affects his/her market and non-market productivity, while his/her stock of health determines the total amount of time he/she can spend producing money earnings and commodities. He uses the household production function model of consumer behavior [Becker (1965), Lancaster (1966), Michael and Becker (1973)] to account for the gap between health as an output and medical care as one of many inputs into its production. This model draws a sharp distinction between fundamental objects of choice – called commodities – that enter the utility function, and market goods and services. These commodities are Bentham’s (1931) ‘pleasures’ that exhaust the basic arguments in the utility function. Consumers produce commodities with inputs of market goods and services and their own time. For example, they used sporting equipment and their own time to produce recreation, traveling time and transportation services to produce visits, and part of their Sundays and church services to produce “peace of mind.” The concept of a household production function is perfectly analogous to a firm production function. Each relates a specific output or a vector of outputs to a set of inputs. Since goods and services are inputs into the production of commodities, the demand for these goods and services is a derived demand for a factor of production. That is, the demand for medical care and other health inputs is derived from the basic demand for health. Thus an important link between the household production theory of consumer behavior and the theory of investment in human capital can be seen. Consumers as investors in their human capital produce these investments with inputs of their own time, books, teachers’ services, and computers. Thus, some of the outputs of household production directly enter the utility function, while other outputs determine earnings or wealth in a life cycle context. Health, on the other hand, does both. Defining health broadly to include longevity and illness-free days in a given year, he points out that health is both demanded and produced by consumers. It is demanded by consumers for two reasons. As a consumption commodity, it directly enters their preference functions, or, put differently, sick days are a source of disutility. As an investment commodity, it determines the total amount of time available for market and non-market activities. In other words, an increase in the stock of health reduces the amount of time lost from these activities, and the monetary value of this reduction is an index of the return to an investment in health. Within this new framework for examining consumer behavior, it is assumed that
individuals inherit an initial stock of health that depreciates over time – at an increasing rate, at least after some stage in the life cycle – and can be increased by investment. Death occurs when the stock falls below a certain level, and one of the novel features of the model is that individuals “choose” their length of life. Gross investments in health capital are produced by household production functions whose direct inputs include the own time of the consumer and market goods such as medical care, diet, exercise, recreation and housing. The production function also depends on certain “environmental variables,” the most important of which is the level of education of the producer, that influences the efficiency of the production process. While we will be discussing this approach in detail in the section on model-building, it would be worthwhile to mention that under certain conditions, Grossman’s model shows that an increase in the shadow price of health may simultaneously reduce the quantity of health demanded and increase the quantity of medical care demanded. Some of the conclusions of the model can be briefly touched upon over here. First, the model predicts that if the rate of depreciation increases with age, at least after some point in the life cycle, then the quantity of health capital demanded would decline over the life cycle. A second prediction states that a consumer’s demand for health and medical care should be positively correlated with his/her wage rate. The model also predicts that if education increased the efficiency with which gross investments in health are produced, then the more educated would demand a larger stock of optimal health. As a complement to Grossman’s paper, is a paper by Rosenzweig and Schultz\(^{15}\) where they estimate a (household) health production function. They point out that despite the emphasis of the household production model on the distinction between production technology and preference orderings, none of the empirical studies based on this approach have attempted to disentangle the household’s technology from its “tastes.” This has mainly been due to the fact that the predictions embodied in the reduced-form demand equations for market goods, derived from the household production model, have not been significantly different from the predictions contained in demand equations from the conventional multi-person consumer demand model (in which all observable goods enter the utility function directly). However, one field where the household production framework appears particularly applicable is health.

\(^{15}\) Rosenzweig and Schultz (1983).
While the household production approach has been employed in this domain, the major focus of empirical work has been on the demand for health inputs, chiefly medical services (Goldman and Grossman 1978; Leibowitz and Friedman 1979). Estimates of the technical/biological effects of such inputs on health, constrained by the limited availability of data on inputs, have been obtained from “hybrid” health equations that contain one or two health inputs and prices and income variables on the right-hand side (Edwards and Grossman 1979). Moreover, these latter studies as well as those in the medical literature have ignored the endogeneity of the (self-selected) health inputs and have thereby implicitly assumed that the population does not differ with respect to exogenous health endowments. However, they argue that innate differences loom large in the distribution of health across individuals and that at least some of these fixed characteristics are known to individuals, who act upon that knowledge. Thus, they estimate a (household) health production function using information on one important early health indicator, birth weight, and a set of behavioral variables considered to be the important determinants of birth outcomes in the medical literature- prenatal medical care, working and smoking by the mother while pregnant, the number of births of the mother, and her age.

Another significant development in approach to modeling health is the paper by Paglin\textsuperscript{16}. The paper is similar to that of Grossman in that both these authors disagree with the fact that health expenditure is mainly considered as investment. Paglin points out that public health projects are typically evaluated in terms of the net capitalized value of the augmented earning stream resulting from the reduction in morbidity and mortality. However, he argues, when applied to the under-developed economies, the deficiencies of this approach becomes evident as in such areas the rate of return on health purely as an investment may be trifling or even negative, when allowed for the effect of reduced morbidity or mortality on the supply of labor and its marginal productivity. The purpose of the paper, therefore, is to integrate public health as a consumer good into the theory of consumer choice and welfare, thus making life expectancy gains comparable to gains in real product. It is in incorporating health as a part of consumer goods, that we see the

\textsuperscript{16} Paglin (1974)
difference from Grossman’s model. Paglin looks at health gains, in the form of greater life expectancy and reduced morbidity, as leading to outward shift in a consumer’s indifference curve. Thus, in his model, other consumer goods compete with health services in two ways: first, these “other goods” also contribute to improved life expectancy as do health services; and, secondly they also directly satisfy other wants of the consumer. Thus a given set of mortality rates can be maintained by various combinations of these two types of goods. However, he cautions that higher life expectancy is positively correlated with greater consumption of both types of goods only up to a certain point: beyond that, it is observed that additional consumption in the form of excess food, cigarettes, alcoholic beverages, automobiles etc. eventually has a deleterious effect, which can only be offset by higher expenditures on health services. Paglin further states that the equilibrium would be reached at the tangency point of the community indifference curve and the production-possibility curve. The actual equilibrium may however lie above or below this equilibrium. He argues that one set of factors which may pull in the below-optimum equilibrium, for example, would be when the individual consumes too little because he/she only considers the possible benefits to himself/herself, and neglects the benefits accruing to others if he/she would undergo treatment for a communicable disease. Another factor could be lack of knowledge in backward areas as to the effectiveness of public health measures in combating endemic illnesses, and the effect of such measures on the energy and productivity of the labor force. Among factors, which would lead to above-optimum equilibrium are those that through demographic externalities reduce the community’s per capita consumption of other consumer goods. He adds that when families demand public or private health services, which reduce mortality and increase population, they neglect the marginal social costs imposed on others, typically in the congestion of free but limited public facilities, and the pecuniary externality in the form of lower marginal productivity of labor and hence lower factor earnings imposed on other families.

These constitute the major trends in terms of determining the importance or value of health. The question of raising the health status of the people in general is more complex. Kethineni (1991) discusses three ideological frameworks which outline the role of state
vis-à-vis the economy and thus also the health sector. On one extreme, we find within the neoclassical approach, the Liberals arguing for a completely market oriented framework claiming that health care is in no significant way, different from other economic goods and services. On the question of health services, the second approach (whom the author calls Paternalists) deviates from the basic competitive market model, arguing in favor of free provision of health care services by the state. The reasons for this deviation are two fold. First, it is argued that health services are not like any other economic good as its consumption (except in preventive aspects) is involuntary. In such cases, the consumer’s consumption of health services is affected by asymmetry of information in the market. Secondly, health services are different from other economic goods in as much as they carry public good content in them. This is so especially in the case of preventive health services like malaria control programs etc. Weisbrod\textsuperscript{17}, for example, discusses the issue of public versus private provision of health. He points out three conditions that a commodity should satisfy so that a social optimum composition of output is to be achieved.

1. Individuals must be able to determine the variety and quantities of goods and services upon which to spend their money.
2. A means must exist to permit individuals to transmit these wants to those who can and will satisfy them.
3. The consumption and production of these goods and services must occasion no significant external economies or diseconomies.

He argues that the commodity, better health, satisfies any of these conditions only quite imperfectly if at all. First, it may not be very simple for a person to decide whether to purchase x percent of medical care so as to reduce the probability of contracting a disease y. Second, while better health is purchasable, it clearly cannot be purchased at a “store”, as can a pair of shoes. Transmitting one’s demand for better health is, therefore, difficult. Third, the external economies of improvements in health are substantial indeed – for example, when communicable diseases and public health facilities such as water

\textsuperscript{17} Weisbrod (1961)
purification and sewerage treatment plants are involved. In a similar vein, Rice\textsuperscript{18} argues against the use of market competition in the provision of health care services and in fact against any goods and services. He points out three assumptions which are required for proper functioning of markets, and which are violated in the case of health services. These are:

1. There are no negative externalities of consumption.
2. There are no positive externalities of consumption.
3. Consumer tastes are predetermined.

On the issue of negative externality, Rice points out the study by James Duesenberry (quoted in Rice, 1998) in which he developed the relative income hypothesis. This states that peoples’ drive for self-esteem makes them wish to emulate the consumption habits of those who are on a higher socioeconomic rung of the ladder. The theory therefore, predicts that people with lower incomes will save a smaller proportion of their income because they will have more frequent contact with those in the economic class just above them, whose consumption patterns they will mimic. Concerning positive externality, he states that it is perfectly natural to expect that people might have a concern that others should have certain things like adequate food or medical care etc. This is especially self-evident in the case of health care services like immunization. Finally, on the issue of consumer tastes being pre-determined he cites experiments done by Aronson, and Ross and Nisbett (quoted in Rice, 1998), which demonstrate that peoples’ tastes and behavior are mutable.

Coming back to the ideological framework, Marxists, on the other extreme, argue for a minimum role for the market and a social system where everything, including health services, should be provided by the state. They argue that even Paternalists, who seemingly demand for a welfare state to provide free health care to all, rely upon the mechanism of state to merely suppress the contradictions inherent in capitalism. These contradictions arise due to the separation of workers from the means of production. This

\textsuperscript{18} Rice (1998)

leads to conflict in the interests of the working class and the capitalist class (which owns the means of production). The survival of capitalist class depends on the rate of accumulation of capital. The higher is its accumulation, the better are its chances of surviving in the market. For this purpose, the wages of the working class are kept at a bare minimum as this increases the profit available with capitalist for their accumulation. However, this can lead to problems when the demand for the goods produced by capitalists fall short of supply. This would imply that their profits will not be realized and can threaten the capitalist system as such. Here the state plays a dual role. On the one hand, it not only provides a market for the capitalist production by consuming its product but also provides an infrastructure in terms of transport, irrigation etc. so as to increase productivity and profitability. On the other hand, it uses its expenditure on social welfare system to control the unemployed surplus population.

Another aspect to the provision of health care and raising the general health status of people can be seen from the perspective of “comprehensive” versus “selective” approach. This refers to the actual methodology used to provide health care services and is also critically linked with who provides these services. The “comprehensive” approach encompasses the Primary Health Care as defined in Alma-Ata Declaration. It defines primary health care as “essential health care based on practical, scientific, sound and socially acceptable method and technology, made universally acceptable to individuals and families in the community through their full participation and at a cost that the community and the country can afford to maintain at every stage of their development in the spirit of self-reliance and self-determination. It forms an integral part both of the country’s health system, of which it is the central function and main focus, and of the overall socio-economic development of the community. It is the first level of contact of individuals, the families and the community with the national health system bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process.” In the framework of “comprehensive”

---

19 Banerji (1984)
20 Alma-Ata (1978)
approach, Terris\textsuperscript{21} defines the concept of public health as that of a major governmental and social activity, multi-disciplinary in nature, and extending into almost all aspects of society. He adds that here the key word is “health” and not “medicine”. The multi-disciplinary character of public health is crucial to the concept as many professional disciplines are involved, for e.g. epidemiology and bio-statistics; health economics, sociology, political science and other social sciences; the biological and physical sciences; public health engineering, nursing, dentistry and nutrition; health education; and, health administration. Banerji\textsuperscript{22} further points out that primary health care is based on a philosophy of health service development. In other words, it is based on people rather than a pre-determined system. It emphasizes social control over health services, involving people at all stages of health service development namely problem identification, program formulation, and program implementation and evaluation. However, the very next year after the Alma Ata declaration, Rocke Fellow foundation came up with the “selective” approach. The basic idea was that comprehensive primary health care was too costly, requiring too large a number of trained staff. The idea of “selective” approach was to give priority to certain diseases according to: (1) their prevalence, (2) the degree of morbidity or disability they cause, (3) their mortality rate (4) and, the feasibility and effectiveness of control measures and the cost of intervention. In fact, in 1982, UNICEF endorsed the selective approach and introduced a primary health care concept known as GOBIFF aimed chiefly at children and pregnant women.

G – Growth chart for children
O – Oral re-hydration salt availability
B – Promotion of breast feeding
I – Immunization
F – Food supplements for pregnant women and young children
F – Family planning

\textsuperscript{21} Terris (1985)
\textsuperscript{22} Banerji (1984)
Banerji further argues that “selective” approach is a contradiction in terms as it adopts ‘authoritarian’ approach and leads to number of limited vertical health programs, leaving other causes of ill health untouched. In fact Qadeer argues that the failure of the Indian case can be traced back to the over-emphasis of vertical program (emerging from the “selective” approach) instead of an integrated or comprehensive health service approach. She also points out that even within vertical programs the priority has been given to family planning, leading to the neglect of others. This lead to pressure for the modification of the entire approach itself ultimately resulting in health sector reforms as part of the Structural Adjustment Program. This had three basic components:

1. Cut in public sector investment
2. Donor driven priorities
3. Privatization of medical care

Qadeer points out that this had a direct impact on the Primary Health Care as:

1. Intersectoral strategies for Primary Health Care were already being undermined by a weakening food security system, massive unemployment and loss of subsistence for many Indians.
2. Infectious disease control programs were disrupted by a reduction in public investment.
3. Medical care was handed over to private sector without any mechanism to ensure quality and standards of treatment, as well as access to services.

Finally, the paper concludes that disease control strategy (as a tool of “selective” approach) had two major drawbacks. Firstly, it over-emphasized individual ‘life-style’, which cannot be changed by the majority of the population who have no option but to survive, under the given condition. Secondly, while emphasis on curative services for a set of diseases only promoted the drug and equipment industry, exclusive reliance on purely bio-medical approach ignored the social and economic conditions in which people

---

23 Qadeer (1)
live and seek help, and which are potentially the main causes of problems that ought to be eliminated. On the role of socio-economic conditions in improving the health status of individuals, there are two important studies done which show the significant role played by socio-economic factors in decreasing the mortality rate. McKeown and Record (1962) investigated the data for the nineteenth century and concluded as follows:

In order of relative importance the influences responsible for the decline of mortality in the second half of the nineteenth century were: (a) a rising standard of living, of which the most significant feature was improved diet; (b) the hygienic changes introduced by the sanitary reformers; and (c) a favorable trend in the relationship between infectious agent and the human host. The effect of therapy was restricted to smallpox and hence had only a trivial effect on the total reduction of the death rate.

The paper goes on to discuss in detail the strength of the evidence on which these conclusions are based. It discusses the alternative explanations and their weaknesses. For example, on the issue of medical measures it says that if the decline of mortality was predominantly due to reduction of deaths from infectious disease, it can be said that until about 1935, it was not due to specific medical measures. This is so because the nature of infectious disease was not understood before 1880; infectious organisms affecting man were not identified until the last quarter of the nineteenth century, and specific prevention or treatment is unlikely to have had much influence on the mortality rate at national levels before the introduction of chemotherapy in the 1930s. This paper looks at the period after 1838 in England and Wales, when the data essential for interpretation of population growth – population size, birth rate, death rate and cause of death – were available. McKeown, Brown and Record (1972) extend the above argument to the pre-registration period (essentially before 1838) when such data were not available, and try to interpret the rise of population in this era. They again look at three plausible explanations for substantial increase in population before the 18th century:

1. Medical measures: The paper argues that if prevention and treatment of disease in the individual did not reduce mortality significantly in the post-registration period (as shown in the article discussed above), it would seem to follow that it had no effect in

24 McKeown and Record (1962), and McKeown, Brown and Record (1972).
the earlier period. It states that virtually nothing was known about the aetiology and natural history of disease before the late nineteenth century. Combined with this fact the knowledge that even till recent years the contribution of immunization or therapy to reduction of the death rate has been limited, it becomes evident that in the eighteenth century marked by absence of understanding of the nature of infectious disease and the mechanism by which it spreads, limited surgery in the absence of anesthesia and knowledge of antisepsis etc. these measures would have hardly been effective.

2. A spontaneous decline of mortality from infectious disease: On this issue, the authors state that it is quite possible that one or more infections may have declined spontaneously in the eighteenth century, as did scarlet fever in a later period, thus leading to some temporary decline in mortality rates. If the expansion of population in the eighteenth century had been short-term, an explanation attaching particular importance to the relation between infectious organisms and their hosts would even seem reasonable. However, they argue that the expansion of population being considered was not short-term but continuous with further growth in the next two centuries. In this case, such explanations are therefore, inadequate.

3. Improvement in the environment: Having discarded the view that medical measures or spontaneous decline in infectious diseases (due to a change in the relationship between the infectious agent and the host), individually or collectively, could account for a reduction in national mortality rates of the size large enough to bring about the kind of population growth that was witnessed between 1700 and 1870, the paper presents the last plausible explanation for this phenomena i.e. substantial improvement in environment. It argues this to be the most plausible explanation on three grounds:

a. There was undoubtedly a great increase in home-grown food, enough, at times more than enough, to feed the enlarged population.

b. In the circumstances which existed prior to the Agricultural Revolution, an improvement in food supplies was a necessary condition for a substantial and prolonged expansion of population.
c. Alternative explanations which can be suggested for the growth of population in the eighteenth and early nineteenth centuries are not credible.

Another study that points out role of socio-economic factors in improving the health status of an individual is by Ravindran (1). This study is done for the scheduled caste population in Chengalpattu district of Tamil Nadu, India. It shows that for the scheduled caste population, both infant mortality rates and probability of dying before the age of five are higher than that for the general rural population, and that material and social deprivation are clearly at the root of inequalities in health experienced by the scheduled caste population under study. It concludes by saying that the most important factors leading to differentials in health status, even within the Scheduled Caste population, are landlessness, exclusive dependence on wage labor, and to a lesser extent, illiteracy; and, that poor housing conditions in a hot and humid climate, lack of protected water supply, and the total absence of sanitary facilities are a major cause of avoidable morbidity such as respiratory problems, worm infections and skin diseases.
Objective

As discussed above, extensive work has already been devoted to the field of public health. However, there exist some gaps between the different works carried out. First, we find that though a significant amount of work on modeling of health issues has been carried out, these tend to concentrate only on health as an investment commodity. The linkage that is focused on is only with respect to productivity. While there has been move towards looking at health as an ‘end’ in itself rather than just as ‘means’ for higher production, this has not modeled on an economy-wide basis. Second, WHO defines health as – ‘a state of complete physical, mental and social well-being and not just absence of disease and illness.’ While this tends to focus totally on the individual as a separate entity, in the modeling of health issues we have not reached even this far confining ourselves merely to the biological well-being of a person. This partly reflects the tendency to focus on human beings only as a capital and partly the difficulties in addressing the complex interactions that take place between an individual and his/her environment. Nonetheless, as mentioned in the last part of the literature survey, these interactions do play a significant role in determining the extent to which an individual can benefit from the health services that are available to him/her. A more comprehensive approach would at least begin with differentiating the individuals based on their economic status etc. and then analyze the impact of different economic programs. Third, we find that there are linkages between private and public provision of health, and the nature of these linkages change as we move from one segment of the society to another. For example, a good public health system would naturally deter individuals from seeking private help. Werner (1995) points out that “just because poor families are willing to pay for medicines, does not mean they can afford to pay for them”. If these expenditures can be saved then this would naturally increase the money poor families spend on health care in terms of nutritional status etc.

25 Qadeer (1985)
The purpose of this paper is not to give a perfect of all the different aspects of health as can be observed in a complex economic structure but to prepare a ground work to develop models for the health sector, for a developing economy like India, in context of the larger macro-economic picture. Given the framework, the paper looks at the effect of reduction in tariff rates across sectors, with a compensatory increase in health investments by the households.

**Model**

In the first stage of modeling health, this paper aims at addressing the first aspect of health i.e. productivity linkage. In this model, health is considered as an investment good. It means that, on one hand, households choose to get medicine and health treatment (i.e. to invest in health) because it provides a certain productivity gain, which is rewarded by firms in the economy through a higher wage for healthy workers on the labour market as it allows for more efficient production. On the other hand, this investment in health also implies a direct cost (e.g. cost of medicines, health consultation fees, etc.), which is entirely supported by the household or by the government or (probably the most credible hypothesis) partly supported by households and partly by the government. Therefore, the real decision of households concerning health is based on a cost-benefit analysis of this investment. Firms and government, in the initial model, only adapts and adjust their behaviour to this households’ decision.

In this note, emphasis will be put on households’ behaviour but firms and government conduct will also be described briefly. The rest of the world account will not be mentioned since health is considered as a non-tradable goods and modeling of this account is therefore perfectly standard.

**Households**

---

26 Eventually, a certain amount of food consumption could be linked to health consumption in order to imply that food can also affect a population health status.
Every representative household $j$ derives utility from consumption of goods, and attributes no value to leisure\(^{27}\) in the following manner:

$$U_j = U(C_1, \ldots, C_i, \ldots, C_n)$$

where $U$ represent a Cobb-Douglas or Stone-Geary utility function that households maximize subject to their budget (income) constraint in order to determine their consumption, $C_i$, of each good $i$.

Households are endowed with amounts of high health and low health workers. In other words, part of their total labour is in a good health status and the other is not. Their income then consists of returns on these two types of labour, dividends and transfers from the government and/or the rest of the world.

Households therefore face, in addition to utility maximization, the supplementary decision of choosing the proportion of the two labour types they want to hold. The model specifies that it is possible for households to invest in health and to consequently affect their relative labour endowments by transforming labour from a low health status to high health status (or reverse). Overall households’ decision must therefore be approached in two steps. Since only income (as opposed to utility) depends on endowments in low health labour, high health labour and money invested in health, households first choose the shares of high and low health labour that maximize their labour income subject to an imperfect transformability of labour into high or low health. In other words, the household problem, in term of income, is

$$\begin{align*}
\max & \quad w \left(1 + h \right) b_j LS_j + w \left(1 - b_j \right) LS_j - c(1 - g)P_g b_j LS_j + DIV_j + PindexTG_j + eTRow_j \\
\text{s.c.} & \quad LS_j = A_j \left( \beta_j \left[ b_j LS_j \right]^{\kappa_j} \right) \left[ (1 - b_j) LS_j \right]^{\kappa_j'}
\end{align*}$$

\(^{27}\) An interesting extension of this model would actually be the integration of leisure since one could think that investment in health has an opportunity cost in term of leisure time (as opposed to work time) used to exercise, to go to the doctor office, etc.
or, written differently, they must choose their amounts of high health and low health workers

\[
Max \ YH_j = w \ (1 + h) \ LShh_j + w \ LSj - c(1 - g)P_h LShh_j + DIV_j + PindexTG_j + eTRow_j
\]

s.c. \quad LS_j = A_j^i \left\{ \beta_j^i \left( LShh_j \right)^i \ + \ (1 - \beta_j^i) \left( LSj \right)^i \right\}^{1/\gamma_j}

where

\[
\begin{align*}
YH_j & = \text{Household } j \text{'s income;} \\
w & = \text{Wage rate;} \\
h & = \text{Productivity gain of being in high health status (endogenous variable driven by firms demand for high health labour);} \\
c & = \text{Average annual amount of health treatment necessary to maintain a worker in high health status;} \\
(1 - g) & = \text{Proportion of health treatment cost paid by households: } g = 0 \text{ if health expenditures are entirely private, } g = 1 \text{ if health expenditures are entirely public (i.e. health system is free for households) and } 0 > g > 1 \text{ if health expenditures are partly private and partly public;} \\
P_h & = \text{Average annual cost of health treatment per person;} \\
b_j & = \text{Share of individuals in the household } j \text{ who receive health treatment and are therefore considered as workers having high health status;} \\
LS_j & = \text{Total (exogenous) potential labour supply of household } j, \text{ i.e. the number of workers in the households;} \\
LShh_j & = \text{High health labour supply by household } j;
\]
\[ LShh_j \equiv \text{Low health labour supply by household } j; \]
\[ DIV_j \equiv \text{Dividends;} \]
\[ TG_j \equiv \text{Government transfers;} \]
\[ P\text{index} \equiv \text{Price index;} \]
\[ T\text{Hrow}_j \equiv \text{Transfers to household } j \text{ from the rest of the world (ROW);} \]
\[ e \equiv \text{Exchange rate;} \]
\[ A_j^i \equiv \text{Scale parameters of the constant elasticity of transformation (CET) function;} \]
\[ \beta_j^i \equiv \text{Share parameters of CET function;} \]
\[ \kappa_j^i \equiv \text{Transformation parameters of the CET function.} \]

The constraint represents the possibility of getting healthier. It indicates that households are unable to increase their shares of healthy workers (or to transform low health labour into high health labour) without any limitation. The straightforwardness with which households are able to complete this transformation depends on the elasticity, i.e. the value of parameter \( \kappa_j^i \).

When choosing \( b_j LSh_j \) and \((1 - b_j) LSh_j \) (or \( LShh_j \) and \( LShj \)) households are analyzing the trade-off between the benefits of having healthier labour, i.e. higher labour income because of the higher productivity, represented by \( whh_j LSh_j \) or \( whLShh_j \) and the direct cost of maintaining the high health status of its healthy labour represented by \( c(1 - g) P_h b_LSh_j \) or \( c(1 - g) P_h LShh_j \). The resulting choice function is:\(^{28}\)

\[ LShh_j = \left\{\left[w(1 + h) - c(1 - g) P_h \right]/w\right\}^{\gamma} \left[\beta_j^i / (1 - \beta_j^i) \right]^{\gamma} LSh_j \]

---

\(^{28}\) This function follows from the first order condition of the preceding constrained maximization.
where \( \tau_j' = 1/(\kappa_j' - 1) \) is the elasticity of transformation. Consequently, when the productivity gain \( h \) or the wage rate increases, household \( j \)'s share of healthy workers increases while when the cost of health investment supported by households, \( c(1-g)P_h \), increases this same share decreases. The magnitude of these variations depends on parameters values and initial labour endowments (or initial human capital level).

Based on this choice, every household then provides to different production activities an amount \( b_j LS_j \) of high health workers and \( (1-b_j)LS_j \) of low health workers. Once these quantities are determined, households then maximize their utility function exactly as in any standard model subject to disposable income (after direct taxation) taking into savings account.

**Firms**

Representative firm of each sector \( i \) use constant return to scale technology and faces perfect competition. It owns part of economy’s capital stock and its remuneration combine with government and/or rest of the world transfers to form its income which is used to pay dividends to households, direct taxes to government and save.

Each sector produces output using capital, high health labour, low health labour, and intermediate consumption. Among these is included a health sector that produces different health commodities, \( XS_h \), also using production factors and intermediate consumption as any other sectors. In fact, output of all sectors results from a combination of value-added and intermediate consumption in fixed proportion\(^{29}\) while value-added, \( VA_i \), is represented as a nested constant elasticity of substitution (CES) function of production factors as follows

\[\text{Function use is then of the Leontieff type.}\]
where

\[ VA_i = A_i^{k_i} \left\{ \left[ \alpha_i^{\mu_i} CL_i^{\rho_i^{\epsilon}} \right] + \left[ (1 - \alpha_i^{\mu_i}) KD_i^{\rho_i^{\epsilon}} \right] \right\}^{-1/\rho_i^{\epsilon}} \]

\[ CL_i = A_i^{k_i} \left\{ \left[ \left( \alpha_i^{\mu_i} P_v_i \right)/wl_i \right]^{-\rho_i^{\epsilon}} \right\}^{\epsilon \rho_i^{\epsilon}} \]

\[ wL_D h_i + w(1 + h)L_D h_i \]
where

- $A_i^\pi$ ≡ Scale parameter of the CES function;
- $\alpha_i^\pi$ ≡ Share parameter of the CES function;
- $\rho_i^\pi$ ≡ Transformation parameters of the CES function;
- $LDl_i$ ≡ Low health labour demand by sector $i$;
- $LDh_i$ ≡ High health labour demand by sector $i$;

Finally, a low health (and high health) labour relative demand must be specified as

$$LDl_i = \left\{ \left[ \frac{\alpha_i^\pi}{(1 - \alpha_i^\pi)} \right]^{\rho_i^\pi} \left[ w(1 + h)/w \right]^{\rho_i^\pi} \right\} LDh_i$$

Consequently, relative demand from firms and relative supply from households of the two types of labour would determine, after simulation, the wage differential between high health and low health wage. In other words, equilibrium on the labour market would determine the value of $h$.

Capital is either mobile or sector specific while labour is (as it is generally the case in medium term static model) mobile among sectors. Moreover, it is worth noting that the possibility of investing in health for households represents a sort of mobility among labour category. It is in part driven by firms demand for the different type of labour, used more or less intensively in different industries, which affects relative labour remuneration.

**Government**
The behaviour of government is relatively simple. It receives income from collection of
taxes paid by the households, firms, production sectors as well as tariffs and export taxes.
It allocates this income among savings, expenditures and transfers to households.

Government expenditures cover for part or for the whole health expenditures in
the economy. Government expenditures function therefore looks like

\[ CTG = \sum_{i=0} GR_{i,eh} P_{C,eh} + GN_h = \sum_{i=0} GR_{i,eh} P_{C,eh} + gXS_h P_h \]

where

- \( CTG \) = Total governmental expenditures;
- \( GR_{i,eh} P_{C,eh} \) = Exogenous governmental expenditures in goods not in health;
- \( GN_h \) = Governmental expenditures in health;
- \( g \) = Proportion of health treatment cost paid by the government: \( g = 0 \) if health expenditures are entirely private, \( g = 1 \) if health expenditures are entirely public (i.e. health system is free for households) and \( 0 < g < 1 \) if health expenditures are partly private and partly public;
- \( P_h \) = Price of one unit of health commodities or treatment;

In terms of government budget closure, because \( XS_h \) exactly covers demand for
health by households and since \( P_h \) can vary (when production cost of health varies), a tax
(indirect or direct) must act as a compensatory variable and adjust in order to maintain
equality of governmental income to governmental expenditures, transfers and savings.
Equilibrium

Equilibrium conditions are equality of demand and supply on each market and are reached through relative prices and wages variation.

Equilibrium on the health market is reached when quantity $X_{S_h}$ of health commodities produced, paid by the government and/or the households, equals the amount of health demanded by households. In other words,

$$X_{S_h} = \sum_j c_{b_j} L_{S_j}$$

On the labour market, total high health and low health labour demanded by production sectors must equal total high health and low health labour supplied by households. In other words, there is equilibrium on the low health labour market when

$$\sum_j L_{SIh_j} = \sum_i L_{DIh_i}$$

and on the high health labour market equilibrium when

$$\sum_j L_{Shh_j} = \sum_i L_{Dlh_i}$$

Calibration and Data Issues
In term of data, the major challenge is to identify what is the initial level of health in each household (i.e. the proportion of high health and low health workers) and with what intensity each production activities uses low and high health level workers. In other words, within the social accounting matrix the labour account must be disaggregated (horizontally and vertically) into high and low health workers. Moreover, a certain initial wage (or productivity) differential between low and high health workers need to be justified. This is embodied in the value of \( h \) so that \( w(1 + h) \) represent high health labour wage while \( w \) represent low health labour wage in the reference situation. Finally, the portion of public versus private, \( g \) vs. \( (1 - g) \), health expenditures must be postulated based on the specific country situation.

Then, considering that we observed equilibrium in the benchmark situation, \( c \) must be calibrated in order to have

\[
w(1 + h) - c(1 - g)P_h = w
\]

so that the share of high and low health labour is stable\(^{30}\).

\(^{30}\) The reverse could also be done: postulate the value of \( c \) and calibrate \( h \).
Appendix I

Evolution of CGE

The distinguishing features of general equilibrium modeling derive from the Walrasian General Economic Equilibrium theory that considers the economy as a set of agents, interacting in several markets for an equal number of commodities under a given set of initial endowments and income distribution. Each agent defines individually his supply or demand behavior by optimizing his own utility, profit or cost objectives. Their decisions yield a set of excess supply functions that fulfill the Walras law, i.e., the global identity of incomes and expenditures. Arrow and Debreu (1954) and others have proved that, under some general conditions, there exists a set of prices that bring supply and demand into equilibrium. This proof known as the economic equilibrium theorem is based on the Brower-Kakutani theorem. The Arrow-Debreu theorem considers the economy as a set of agents, divided in suppliers and demanders, interacting in several markets for an equal number of commodities. Each agent is a price-taker, in the sense that the market interactions, and not the agent, are setting the prices. Each agent is individually defining his supply or demand behaviour by optimising his own utility, profit or cost objectives. The theorem states that, under general conditions, there exists a set of prices that bring supply and demand quantities into equilibrium and all agents are fully (and individually) satisfied. The Brower-Kakutani existence theorem is constructive in the sense of implementing a sort of tâtonnement process around a fixed point where the equilibrium vector of prices stands (see Figure 1). Models that follow such a process are called computable general equilibrium models.

Computable general equilibrium (CGE) models turned the above theory into an operational model to be used initially for comparative static analysis and later for dynamic as well. CGE models simultaneously determine changes in quantities of goods supplied and demanded, and their prices, in an aggregated multi-sectoral and multi-agent setup. Facilitated by the explicit representation of markets, the CGE models have often been extended beyond the original Walrasian framework to model market imperfections
and other economic mechanisms that deviate from the original general equilibrium paradigm. For this and other similar reasons, some authors used the term “generalized equilibrium modeling” (Nesbitt, 1984) or “general equilibrium programming” (Zalai, 1982a) to underline the flexibility of the computable general equilibrium models.

CGE models have grown out of and combine different modelling traditions. The first CGE model, L. Johansen’s Multisectoral Growth (MSG) model (Johansen, 1960) was built for Norway. The MSG model was a combination of the dynamic Leontief-type (input-output) model with macroeconomic production and consumption functions, thus extending the input-output model with relative price-driven substitution possibilities. Many models followed or were inspired later by Johansen’s pioneering work both in Norway (see, for example, Longva, Lorentsen and Olsen, 1985), and elsewhere (see, for example, the ORANI model in Australia, Dixon et al., 1982).

In a related but somewhat different approach Jorgenson and his associates combined the input-output model with macro functions based on the econometric tradition (see, Hudson and Jorgenson, 1974 and 1977; Jorgenson, 1984; Jorgenson and Wilcoxen, 1990a and 1990b).

The 1970s and the 1980s witnessed a widespread use of CGE models for the analysis of economic development problems in developing countries (see, e.g., Adelman and Robinson, 1978; Dervis, De Melo and Robinson, 1982; Devarajan, Lewis and Robinson, 1987). These models have enriched the CGE modelling tradition extending the focus of the previous models with elaborate treatment of foreign trade, income distribution and various policy instruments. Many of these models have further departed from the Walrasian concept by including “structuralist” features into the general equilibrium framework (see, for example Taylor and Black, 1974; Taylor and Lysy, 1979).

A significant source of inspiration for CGE modelling was the competitive general equilibrium interpretation of the primal-dual solutions to linear programming (LP) models of nation-wide resource allocation. LP models were extensively used in the 1960s
and 1970s for economic policy analysis, both in developing and centrally planned economies. A distinct method that developed from that tradition was the activity analysis approach to CGE models (Ginsburgh and Waelbroeck, 1981).

Harberger’s (1962) early numerical two-sector model analysing the incidence of taxation and the pioneering work of Scarf (1973) presenting the first constructive method for computing fixed points initiated another distinct trend of general equilibrium modelling, oriented chiefly towards the study of tax policy and international trade (see, for example, Shoven and Whalley, 1972 and 1984; Scarf and Shoven, 1984; Fullerton, King, Shoven and Whalley, 1981; Pereira and Shoven, 1988). Shoven and Whalley provided a state-of-the-art methodology for model calibration and formulating multi-national market clearing mechanisms in a general equilibrium framework.

A more recent trend in computable general equilibrium modelling involves incorporating an IS-LM mechanism (termed also macro-micro integration), which has been traditionally used in Keynesian models. The ensuing hybrid models have been proposed by Bourguignon, Branson and De Melo (1989) and others. These models often incorporate additional features that enhance their short or medium-term analysis features, such as, for example, financial and monetary constraints, rigidities in wage setting.

Another recent development was the incorporation of economies of scale and non-competitive (oligopolistic) market structures into the CGE framework, in order to model the effects of trade liberalisation and integration on micro efficiency. The forerunner of these models is Harris’s (1984) pioneering work and the partial equilibrium models of Smith and Venables (1988). In the 1990s several models carried this line of research further, including Harrison, Rutherford and Tarr (1994); Willenbockel (1994); Burniaux and Waelbroeck (1992); Capros et al. (1997).
References


September, Cambridge, Ma..


Leibowitz, Arleen, and Friedman, Bernard S. (1979) “Family Bequests And The Derived Demand For Health Inputs.” *Econ. Inquiry* 17 (July): 419-34.


Ministry of Health, Government of India, National Health Policy, http://mohfw.nic.in/kk/95/ii/95ii0101.htm


Terris, Milton (1985), “The Distinction Between Public Health And Community/Social/Preventive Medicine”, *Journal Of Public Health Policy*


