PRICING OF HEALTH SERVICES
A CASE STUDY OF
SREE CHITRA TIRUNAL HOSPITAL IN KERALA

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I hereby affirm that the research for this dissertation titled, ***"Pricing of Health Services: A Case Study of Sree Chitra Tirunal Hospital in Kerala"*** *being submitted to the Jawaharlal Nehru University for the award of the Degree of Master of Philosophy in Applied Economics, was carried out entirely by me at the Centre for Development Studies, Trivandrum.*

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Certified that this dissertation is the bonafide work of Sri. Hari Kurup K.K. This has not been considered for the award of any other degree by any other university.

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Chapter I

INTRODUCTION

Improvement in health status is vital to the enhancement of human capabilities. It is thus rightly a priority on the developmental agenda of nations. Developing countries as a whole, expenditure on health accounts for about 5 per cent of total public expenditure and, on an average 2 to 4 per cent of the Gross Domestic Product (Feldstein, 1983). India, like other developing countries, has given a high priority to the health status of its people. However, the proportion of planned public investment allotted to health sector has declined from 3.3 per cent during the First Plan to 1.9 per cent in the Seventh Plan. With continuing resource constraint of the government and competing sectoral demands, the allocation to the health sector may not be expected to increase. Further the present trend of cut in government subsidies is likely to put more pressures on this sector. This stands in contrast to the principles of the structural adjustment programme, as perceived by the World Development Report (1987). The Report recommends change in the revealed preference of the government from directly productive activities to investments in social sector and infrastructure.

In this scenario, it becomes imperative to examine alternate possibilities of mobilising resources for the sector. These alternative ways include cost containment measures and cost sharing methods (Lalta, 1991). Although the adoption of these alternate measures would reduce the dependence of health sector on government budget, it would require large scale intra-sector reforms.

However, improving resources from within through the introduction of user charges would augment revenue in a much simpler manner without involving radical reforms. This study, thus, attempts to analyze how appropriate pricing of health services would improve the resource potential of this sector, while giving due consideration to the welfare implications involved in the provision of this public utility. In search for such an alternative, the study addresses to the following questions:

First, as provision of health service is a welfare measure pursued by the government, is it justifiable to price the health service?

Second, having decided to price, what should be the pricing rule to be followed? and, third

Who should be priced?

The subsequent discussion is carried out in keeping these questions in the background.

1.1 The question of equity:

The existing system of absence of user charges or 'zero prices' yields hardly any revenue to this sector. Moreover, it is argued that the existing policies in the health sector are ill-suited to cope with the delivery of health services across different income groups whereby huge disparities exist in the distribution of health services. As health service is a public utility, it should be provided to all needy persons from an equity point of view. However, Jimenez (1989) argues that free provision does not ensure that the poor will get more or even their proportionate share of the subsidies. This is evident from table 1.1.

Table 1.1

Who Gets Social Sector Subsidies ?

Country and Sector	Year of Survey	Percentage of Government Subsidies Received by Income Group		
		Lower (40%)	Middle (40%)	Higher (20%)
Public Health				
Argentina	1980	69	27	4
Columbia	1974	42	40	20
Costa Rica	1983	49	38	13
Chile	1983	51	47	11
Dominican Republic	1984	57	44	9
Uruguay	1983	64	25	12
Indonesia	1978	19	36a	45b
Iran	1977	51	37	13
Malaysia	1974	47	37	17
Philippines	1975	27	33	40
Sri Lanka	1978	46	39	14
Hospitals				
Columbia	1974	23	53	23
Malaysia	1974	36	34	20

a - These figures are for the middle 30 percent.
b - These figures are for the upper 30 per cent.
Source: Jimenez (1989)

As can be seen, in four out of eleven countries, the lowest 40 per cent of the people (in terms of income) do not get a proportionate share in the government subsidies. Uniformly low prices for health services means that expensive services are much more subsidised than cheaper ones. However, the poor people have least access to these high cost services for a variety of reasons, including the high private cost of consumption and built-in biases when services are rationed. The limited resources devoted to social services are badly used. Jimenz contends that only too little goes to cheaper, more cost effective alternatives, partly because there is no pricing mechanism to impose discipline either on users or on providers. Thus, it has not fulfilled the objective of promoting equity in the distribution of health services.

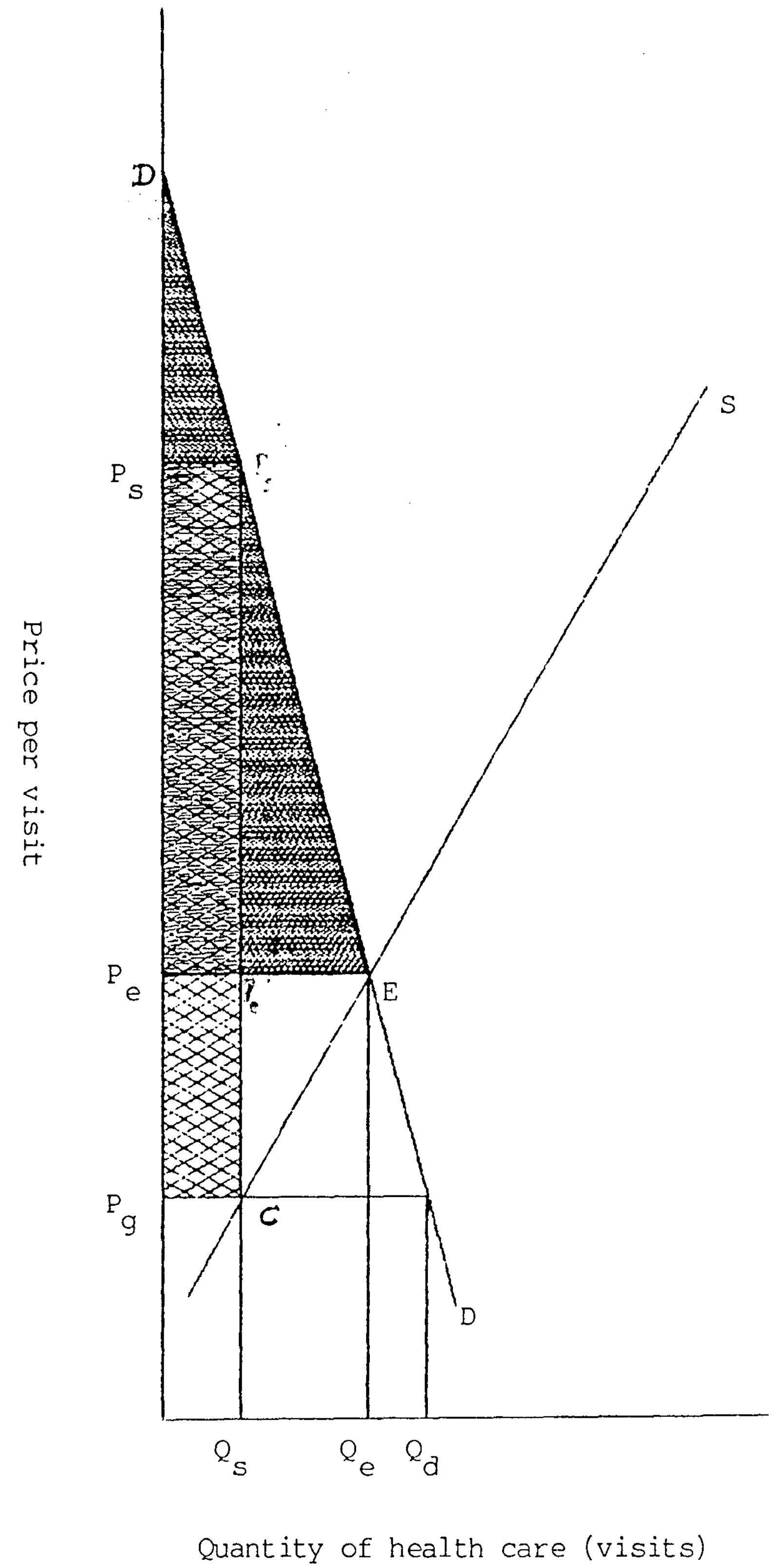
1.2 The question of efficiency:

Current policy of absence of user charges may hinder efficiency because of distortionary tax policies pursued to raise the public revenue which finances health services (Griffin 1992). The existing situation of inefficiency in the absence of user charges vis-a-vis improvement in its efficiency with the introduction of efficient prices is illustrated in Figure 1.1.

At the government price Pg, the quantity supplied is Qs and the quantity demanded is Qd. People who would willingly pay Pg are not able to get service at that price. Although the health services supplied could command a higher price Ps due to higher demand for it, it is charged at Pg.

Consumer surplus at the current price is the area DPgC, indicating that people who are willing to avail the health services are benefiting enormously. By raising the price Pg to the market clearing price Pe, thus surmounting the constraint of inadequate government health budgets, more consumers will be served, and they will voluntarily pay for services which has moved from Qs to Qe. This equilibrium entails both higher price and service delivery. This leads to an increase in the consumer surplus, the triangular area (DEP_e) in the Figure 1.1.

Figure I.1 Consumer surplus under market conditions



The situation depicted in the above figure is probably close to the scenario currently prevailing in most developing countries, where the charges are negligible. And, it is likely that the new situation will improve the consumers surplus as a whole, including those who were served at the previous low price. As the above figure illustrates an overall improvement in welfare of the consumers, it may not still overcome tendencies that favour a few advantaged groups at the expense of disadvantaged majority.

If people with low income are charged reduced fees, consumer surplus can, further, be increased (this can also be observed from the above figure). If the quality of health services is improved[1] with a rightward shift in the supply curve, the scope for raising consumer surplus would, further, be expanded.

It must be ensured that by charging the health services, no one is deprived of the benefits of health care. This calls for advocating a system of differential pricing across different income groups and thus, ensuring that charging for health services should depend on the ability to pay.

As in most welfare states, it is not the objective of revenue maximisation, but efficient provision of health services which needs careful attention. This calls for an economically efficient way of recovering the costs involved.

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[1] Such improvements are always advocated as part of a policy of imposing user charges

1.3 Issues in health sector:

The health sector lacks the usual market forces to be efficient. Further, Khan and Berman (1993) have argued that the health care is a commodity that is widely traded in a chaotic private market-place where the consumer often feels helpless and ignorant. Hence, government intervention is indispensable. However, as mentioned earlier, given the constraint on the government budget, it appears that pricing of health services becomes essential to recover the cost by charging users. This leads us to the question of the pricing rule to be followed, which, in turn, calls for examining the nature of market for health service.

The demand for health outstrips its supply. The health consciousness among people sustains a continuous demand for better health care facilities. Newhouse and Phelps (1987), Griffin (1987), Avinchey and Yannapoulos (1992) have observed that the demand for health care is inelastic with respect to price. It implies that charging health services could be an effective means of raising revenue. To quote Griffin, " both the theory and evidence on price elasticities and expenditures suggest that demand for most type of medical care in developing countries is quite insensitive to prices and that revenues will almost certainly rise when fees are either introduced or increased" (Griffin, 1987). It may, therefore, be inferred that the demand for health service is given at a particular point in time.

Redisch, Gabel and Blaxall (1981) identify two views regarding the market for health services. One view upholds that physician is the dominant force in determining medical care utilization patterns. The other view is that the primary motivating force behind the allocation of medical goods and services is consumer preferences manifested through market prices. However, in the Indian context, it may be expected that the physician's role is crucial. Hence, it can be said that the optimum service is not determined by the usual market forces, but supplier (physician) determined. As observed by Redisch (1978), it is the physician who recommends admission, takes responsibility for ordering diagnostic procedures, therapeutic measures and determines when the patient is fit to leave the hospital. However, the physician cannot control the overall hospital costs and hence, pricing. The prices of medicines, overhead costs, costs of surgery, administrative expenses etc., fall beyond the control of the physician. Hence, the 'physician dominance' argument seems to be less relevant to our analysis of pricing of over all health services.

It is, therefore, essential to review the different approaches to charging users. As mentioned earlier, the health sector is a public utility, and hence, pricing formulations of public utility are discussed[2].

1.4 A brief review of public utility pricing:

The most and widely used public utility pricing rule is that of the marginal cost pricing. Here price is set equal to marginal cost, whereby the total surplus, sum of consumer surplus and producer

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[2] Although most pricing theories have been developed in the context of goods rather than services, it is assumed that the principles applicable to goods are also applicable to services.

surplus, is maximum. The deficiency in cost recovery arising out of setting prices at marginal cost would be made good with a subsidy (Hotelling, 1938). However, the marginal cost pricing does not cover fixed costs. And, whenever average cost is declining with increased output and marginal cost is less than average cost, marginal cost pricing will fail to break even.

It is in this context that Ramsey (1927) speaks of a second best pricing rule with a mark-up. The formula for the second best mark-up of price over marginal cost (MC) in each market is given by

$$\text{Mark up} = \frac{Pi - Ci}{Pi} = \frac{k}{Ei}$$

where Pi is the price, Ci is the MC and Ei is the price elasticity of demand in the market i. Thus, the low elasticity markets are characterised by high mark-ups and high elasticity markets by low mark-ups. The proportionality constant k adjusts mark-ups in all markets uniformly to the point where the firms break even.

This Inverse Elasticity Rule can be written as

$$k = \left[\frac{Pi - Ci}{Pi}\right] Ei = \left[\frac{Pj - Cj}{Pj}\right] Ej \qquad j =/= i$$

In other words, for any pair of markets served by a regulated firm, the percentage deviation from MC, weighted by price elasticities of demand, should be equal for both markets.

The classical Ramsey problem for a multiproduct enterprise is to maximise social welfare, while allowing the regulated enterprise to cover all its costs, including a normal return on all capital investments (Brown and Sibley, 1986). Thus, in a regulated monopoly, the tariff is designed to maximise consumer's surplus, namely, the aggregate of customer's net benefits, subject to the revenue requirement. The net effect of Ramsey pricing is to reduce the percentage of profit margin on each unit sold until the utility's revenue equals its total cost.

As an extension of Ramsey's second best solution, a third best pricing rule for public utilities was developed by Danielson, Kamerschen and Keenan (1989). They argue for the setting of an overall revenue requirement along with a pre-specified allocation of revenue responsibilities among different classes of customers.

Besides these, there is an important method to allocate the common costs is the Fully Distributed Cost approach (FDC). This approach puts forward three different ways of allocating common costs, namely, the Relative Output Method (ROM), the Gross Revenue Method (GRM), and the Attributable Cost Method (ACM) (Braeutigam, 1980). All these methods consider allocation of common costs to different services based on their relative share in output, revenue and attributable costs. Algebraically, the FDC of a service i can be written as

$$FDC_i = \text{Attributable Cost of } i + f_i * \text{Common Cost}$$

where f_i is the fraction of common cost attributed to service i, This fraction is given by

$$FDCi = \frac{\text{Output of } i}{\text{Total Output}} \quad \text{under ROM}$$

$$= \frac{\text{Revenue of } i}{\text{Total revenue}} \quad \text{under GRM}$$

$$= \frac{\text{Attributable cost of } i}{\text{Total Attributable cost}} \quad \text{under ACM}$$

Although all these approaches relate to public utility pricing, no approach specific to health sector is discussed. The subsequent discussion is, therefore, focussed on the approaches to health sector pricing.

1.5 Review of literature on health sector pricing:

The work in this area can be broadly divided into those that intend cost recovery without consideration of equity and efficiency and those which consider both.

Ray (1975) formulated a methodology for allocating hospital costs, both recurrent and capital costs, among the inpatients and the outpatients[3]. In his framework, the total recurrent (R) expenditure, T_j^R, in hospital j is decomposed into administration A_j^R, inpatient care[4] in service i, I_{ij}^R, and outpatient care[5] in

[3] The study pertains to the Malaysian hospital systems.

[4] The recurrent cost per day of inpatient care is calculated by dividing total inpatient expenditure by total hospital admissions.

[5] The total outpatient recurrent expenditure is obtained by summing up expenditure on the following inputs (i) outpatient clinic personnel; (ii) personnel engaged in outpatient-related activities in the pharmacy, laboratory and x-ray departments; (iii) pharmaceutical; (iv) X-ray film; and, (v) laboratory materials.

service i, O_{ij}^R, namely,

$$T_j^R = \Sigma_i Iij^R + \Sigma_i Oij^R + A_j^R$$

After estimating O_{ij}^R and T_j^R, he arrived at $\Sigma_i I_{ij}^R + A_j^R$. Assuming that A_j^R is negligible, the difference between T_j^R and O_j^R yields the total inpatient cost. However, this assumption needs careful consideration, since the estimated administration cost in his model comes around 10 per cent of the total recurrent cost. Hence, combining it with inpatient costs is likely to inflate the inpatient cost.

As regards capital cost, the following procedure has been adopted. Let the weighted capital cost per bed[6] be X, the opportunity cost of capital be r, annual amortization factor be ß, and share of outpatient services in total recurrent expenditure be α, then capital cost per outpatient is equal to

$$\frac{\Gamma_j \; \alpha \; (r + ß) \; X \; (BEDS)}{\text{Total outpatients in hospital } j}$$

where Γ_j =the share of outpatient services in total recurrent costs in hospital j.

The capital cost per inpatient day equals

$$\frac{(r + ß) \; X \; (1 - \alpha\Gamma_j) \; (BEDS)}{\text{Total inpatient days in hospital } j}$$

[6] Weighted capital cost per bed is obtained by weighing the cost per bed by the number of beds in each hospital.

However, this formulation emphasizes the estimation of a weighted average of capital costs per patient among hospitals, ignoring the calculation of cost per bed in a particular hospital. Since hospitals provide services which are highly heterogenous in terms of resource use, a simple average of capital cost per bed across different services will be misleading. Any estimation of capital cost should, therefore, start with a proper measurement of capital costs per bed across services within a single hospital before estimating it for the hospitals as a whole.

Though there are some other works (Lee, 1971; De Ferranti, 1985; Griffin, 1987; Jimenez, 1987; Lalta, 1991; Akin and others, 1987) which advocate user charges in the health sector, no methodological formulations are available.

Lee (1981) demonstrates a pricing model for hospitals, treating the pricing procedure as a special case of full cost (full expenditure) pricing policy. In his model, philanthropic payments are subtracted directly from total input cost which in itself is directly used as a measure for pricing. Thus, the model is more concerned with cost recovery than the question of equity. DeFerranti (1985), favouring health sector pricing, argues that there is no uniform thumb-rule for pricing. Further, curative services and patient-related preventive cases must be subject to efficiency pricing; other non-patient related preventive cases should not be priced. Lalta (1991) highlights two major objectives of user fees; first, the generation of revenue and second, the restriction and rationing of demand in view of over demand when charges are absent or minimal.

Akin and others (1987) advocate user charges for health services in developing countries. The market for health services is not in equilibrium because governments are holding the price of health care below the market clearing price. According to them, the long queues and poor access indicate rationing of services because of excess demand at the subsidised price. Further, considering the inadequate staffing and drug shortages, they argue that the governments can supply only inadequate levels of output, given the budget constraints and inefficient delivery systems. Thus, Akin and others question the efficiency of health delivery system in a situation where market clearing prices are absent. This raises the issue of pricing of health services with the consideration of efficiency and equity.

Feldstein P J (1983), emphasizes the need for efficiency while pricing the health services. Cairns and Snell (1978) also suggest allocative efficiency of health services under pricing, whereby both providers and patients are encouraged to minimize wastes.

1.6 Objectives of the study:

The present study is carried out with the general objective of evolving a model for pricing health services. The specific objectives are:

i. to examine the existing system of cost recovery and pricing in the Sree Chitra Tirunal (SCT) hospital with regard to economic efficiency and equity.

ii. to analyse the cost structure of the SCT hospital in an appropriate and theoretically consistent framework to arrive at a pricing solution.

iii. to evolve a pricing formula for the health sector, incorporating welfare considerations.

1.7 Sources of data and methodology:

A major limiting factor in the study of pricing of health services is the non-availability of adequate and appropriate data. This is sought to be overcome by use of reliable primary data. The SCT hospital has been chosen for the purpose of the present study, in view of their systematic documentation[7].

The data are mostly drawn from the financial statements and the medical records. In addition, a sample survey is also conducted to ascertain the share of out-patient services in the total expenditure through estimating the laboratory expenses for out-patient services of the hospital.

The selection of samples involves two steps. At the first stage, a purely purposive selection is made. The heads of all departments, except Radiology, provided a sample of representative cases which they handled during the period June 1993 to September 1993. Then, an equal number of cases, 25 cases, are taken from each department at random. Based on this, the total number of in-patient laboratory investigations are calculated, substraction of which from the total number of laboratory investigations of the hospital as a whole give the number of out-patient laboratory investigations. The proportion of out-patient to total number of laboratory investigations is taken as a measure of the share of

[7] The Chapter II presents a brief account of the existing mode of functioning and the nature of health services provided by SCT hospital along with the pattern of cost and revenue.

expenses on out-patient services in the total expenditure of the hospital. This is used as a weight to apportion the common cost between the in- and out-patients. Thus, this procedure limits the pricing problem to the case of in-patient services alone.

Based on the review of methodology on pricing[8], it is seen that a single solution for pricing would not be of much use. Hence, two alternatives are sought. The possible alternatives are as follows:

1) An Efficiency Pricing
2) Pricing with Efficiency and Equity

1.8 Chapter scheme:

The study is organised in five chapters. Chapter Two documents the relevant organisational features of SCT hospital. Analysis of cost structure in a multiproduct framework has been done in the third chapter. Chapter Four discusses the pricing solution using a non-linear multiproduct pricing. The concluding observations are presented in the last chapter.

[8] The methodology of estimation of costs and pricing has been presented in the relevant contexts of the subsequent chapters.

Chapter - II

THE SREE CHITRA TIRUNAL HOSPITAL: AN OVERVIEW

The SCT hospital was started in 1973 when the erstwhile royal family of Travancore donated a multi-storied building which the Government of Kerala resolved to develop as the Sree Chitra Tirunal Medical Centre for medical specialities. The Government of India declared it as an Institute of National Importance by an Act of Parliament in 1980. Following this, the SCT hospital has been conferred autonomous status, affiliated to the Department of Science and Technology. This hospital is unique with its specialization in Neurology and Cardiology and is a spatial monopoly in the services which it provides.

This institute accepts only those cases which are referred by other public hospitals or by qualified private practitioners. Prior appointment letters are sent to the patients fixing a date for registration and examination as soon as their doctor's letters are received. Since all investigations are to be completed on the day of registration itself, the number of cases called for registration are limited to 25 in each department. No emergency admissions are entertained.

2.1 Medical services provided in SCT hospital:

There are six departments in the hospital, namely, Cardiac Medicine, Anaesthesiology, Cardio Thoracic and Vascular Surgery, Neuro Surgery, Neuro Medicine, and Radiology. These departments can be classified under two broad titles - Cardiology and Neurology. The departments of Cardiac Medicine and Cardio Thoracic and Vascular Surgery fall under the Cardiology branch whereas Neuro

Surgery and Neuro Medicine come under the Neurology branch. Anaesthesiology and Radiology are service departments for the others. However, for the purpose of empirical estimation that follows in Chapter Three, these departments have been classified into Medical and Surgical departments. While the medical departments consists of Cardiac Medicine and Neuro Medicine, the Surgical department constitutes the rest. Of these, Anaesthesiology department does not admit patients of its own; Radiology offers a few interventionary therapeutic services.

2.2 Quality of service in SCT hospital:

Improvement in the quality of the services provided by hospitals is reflected in the reduction in the average length of stay[1] of admitted patients in the hospital as a whole. The average length of stay of a patient admitted in SCT hospital has fallen from 19 days in 1977 to 11 days by 1992-93[2] which evinces the improvement made in the quality of services provided by SCT hospital.

Analysis of the mortality rates in total and the rate of mortality at the time of surgery highlights the quality of health care. Both these rates are found to be very low for SCT, as is evident from the Table 2.1.

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[1] The average length of stay is obtained by dividing the total inpatient days in an hospital in a year by the total number of discharges.

[2] A Detailed discussion of the length of stay is attempted in Section 2.4 of this chapter.

Table 2.1
Mortality rate in SCT hospital

Year	Mortality Rate (%)	Operative Mortality Rate (%)
1977	6	7
1978	6	9
1979	8	7
1980	6	4
1981	6	3
1982	6	6
1983	7	8
1984	8	10
1985	6	8
1986	7	8
1987	6	3
1988	6	3
1989	5	4
1990	5	3
1991	6	4
1992	5	6

Source: Medical Records Department of SCT hospital

However, it is worth noting that the operative mortality rates, though declines on a point to point basis from 1977 to 1992-93, actually reflects a fluctuating behaviour. But this could be attributed to the chance factor.

2.3 Admissions to SCT hospital:

The hospital admissions are essentially based on the number of beds, new cases and repeat cases. The number of beds sanctioned in the hospital has remained constant for years together only some discrete quantum upward jumps are visible. The number of beds in 1977 was 84. It rose to 200 by 1985/86 but since then it has remained the same. The number of new cases was steadily rising till 1990/91. From 10322 in 1991/92 it declined to 9259 by 1992/93. The number of repeat cases too was increasing steadily till 1991/92. But it registers a slight fall from 28880 in 1991-92 to 27276 in 1992/93.

With the steady increase in the number of new cases and repeat cases, excepting for the year 1992/93, the total inpatient admissions had also increased. The reduction in new cases and repeat cases have reflected in the number of admissions. The relationship between total admission and the total number of new cases and repeat cases are well captured by their corresponding correlation coefficients, which was 0.98 and 0.87 respectively.

2.4 Length of stay:

The length of stay is an important factor which determines the extent of inpatient admissions in the hospital, for the total number of beds remains constant. When the average length of stay falls, more patients can be admitted. As mentioned earlier, the decline in the length of stay is considered as an improvement in the quality of service provided in the hospitals. However, there can be two major reasons which lead to a reduction in the average length of stay of admitted patients: the expansion of medical technologies which reduces the time taken to diagnose the disease and a shift in the case-mix. In the case of SCT hospital, the average length of stay has declined from 19 days in 1977 to 11 days by 1992-93. The department wise break up of the length of stay is shown in Table 2.2.

Based on the Table 2.2, the longest length of stay has been recorded by Neuro Surgery department with 16.90 days whereas the Cardiology department registered the shortest length of stay with 8.13 days. It implies that Neuro surgery has the highest patient severity for longer length of stay implies high intensity of the ailment treated.

Table 2.2

Number of cases and length of stay - 1992/93

Departments	No. of OP	% to total	No. of IP	% to total	Length of stay
Cardiac Medicine	5529	59.71	1434	35.25	8.13
Cardiac Surgery	---	0.00	431	10.59	13.12
Neuro Medicine	2095	22.63	666	16.37	14.94
Neuro Surgery	1038	11.21	745	18.31	16.90
Neuro Radiology	34	0.37	27	0.66	10.32
Thoracic Surgery	563	6.08	765	18.81	13.77
Total	9259	100.00	4068	100.00	12.45

Note: OP is the outpatients and IP is the inpatients
The total length of stay is the weighted average with the number of inpatients as the weight.

Source: Same as Table 2.1

2.5 Exclusion system in SCT hospital:

The existing pricing procedure in SCT is not based on any specific economic principle. What is currently pursued is a kind of differential pricing based on the patient's ability to pay. The ability to pay is ascertained by a group of social workers based on an interview with the patient. Patients are categorized into paying and non paying groups according to their monthly income. The charges are fixed on the basis of monthly income as given in Table 2.3. It is seen in the table that patients with a monthly family income of more than Rs. 1000 would receive no concession while the concession enjoyed by patients having monthly family income of less that Rs. 1000 vary across sub-categories from 20 to 100 per cent.

Table 2.3
Class[illegible]on of patients based on Income category

Patients' category	Patient's Monthly Family Income	Concession (Percentage)
Grid 'A'	less than Rs 300/-	100 % free
Grid 'B1'	Rs 301 - Rs 500	50 % free
Grid 'B'	Rs 501 - Rs 1000	20 % free
Grid 'C&D'	Rs 1001 and above	0 % free

Recently, a system of dual pricing has been introduced, that is, at a time only 20 per cent of the patients falling under Grid A be admitted for treatment. The remaining patients from Grid A have to wait for their turn. In event of immediate need for medical care for such patients, moving to a higher grade, say C or D, is possible by paying user charges.

2.6 Waiting to get service:

As mentioned earlier SCT is basically a super specialty hospital. The hospital functions hand in hand with the Research wing - The Bio Medical Technology wing. The institute is well equipped with modern scientific equipments. But the number of beds in the hospital is comparatively low. The total number of beds in the hospital is only 200 which are allocated in the six departments of the hospital as given in the table below.

Table 2.4
Department wise allocation of hospital beds

Name of the Dept.	Number of Beds	Percentage to total
Cardiology	42	21.0
Radio Surgery	43	21.5
Neurology	39	19.5
Neuro Surgery	44	22.0
Thoracic Surgery	26	13.0
Radiology	4	2.0
Emergency Beds	2	1.0
Total	200	100.0

Source: Same as Table 2.1

Because of a very limited availability of beds, the hospital is unable to meet the growing demand for its services. The existing lower rate of charges compared to the other hospitals and the position of SCT hospital as a spatial monopoly[3] raises the demand for its services. Added to it is the quality of the services provided in SCT hospital, which attracts patients from all over India and abroad as well. All this culminates in a high demand for the services which the hospital provides. Given the limited supply of medical services, measured in terms of number of beds, the hospital cannot accommodate all the patients. This leads to a mismatch between supply of and demand for the services entailing in queues for getting services. These queues pose problems which have allocative implications. If queue is used as an allocative device for medical care, people must be physically present to pay the "time price" of waiting to get service. The main economic problem with this allocation mechanism is that it is based on a physical entity that cannot be traded or borrowed (Griffin, 1987).

2.7 Cost recovery in SCT hospital:

Ever since its inception, the SCT hospital had a certain mild forms of cost recovery mechanism. The existence of user fees have been a driving force in the growth and advancement of the hospital which has benefited both the hospital and patients. While the collection of user fees has ensured the SCT hospital some degree of financial autonomy indispensable for its smooth functioning, it had benefited patients with an improvement of quality of the services

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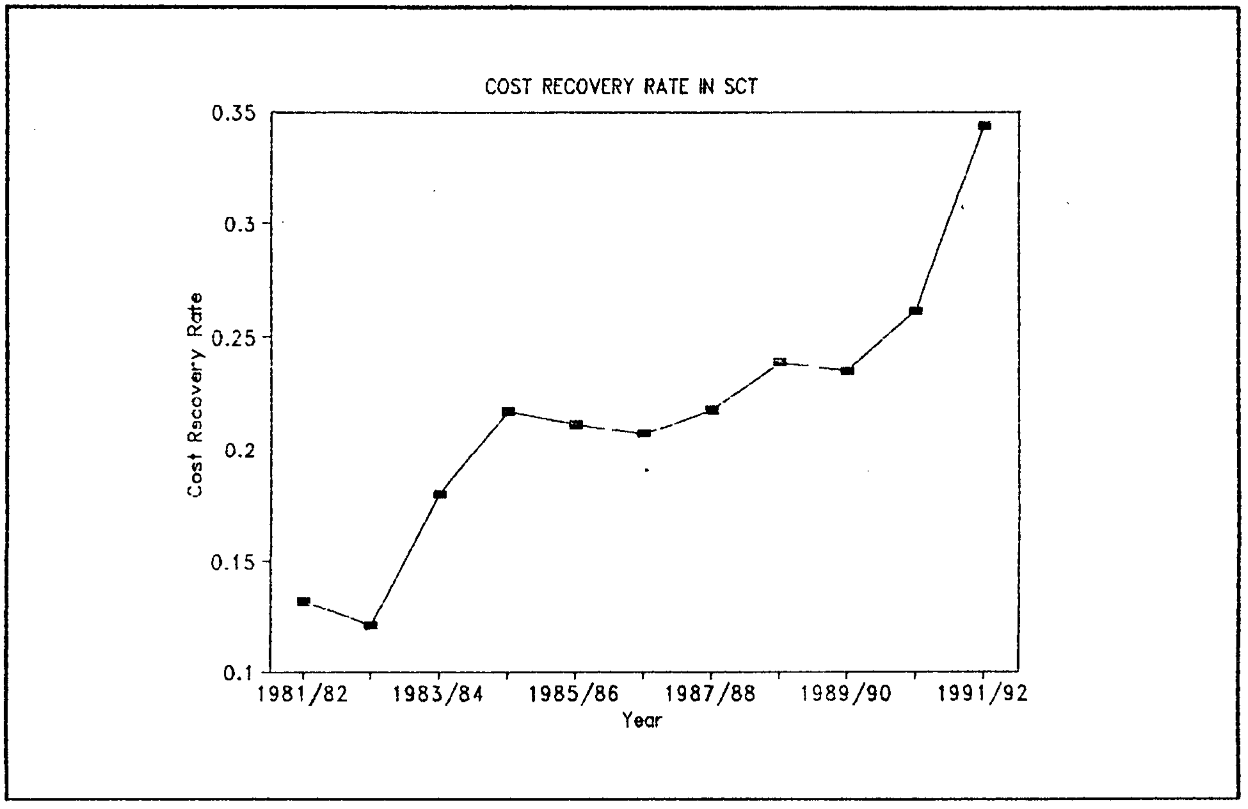
[3] It may be noted that SCT hospital is the only public sector super speciality hospital dealing cases of Cardiology and Neurology in Kerala.

provided by the hospital. As discussed above, the quality of the services provided in SCT hospital is better than any public sector hospitals and is comparable even to the private corporate hospitals.



Due to these reasons the implementation of the user fee system in SCT hospital finds relevance. Various attempts were made to recoup at least the operating cost incurred in the hospital. Although there is considerable improvement in this regard, it has not enabled the hospital to recoup its operating cost. The cost recovery rate[4] has gone up from 0.13 in 1981/82 to 0.35 by 1991/92. The cost recovery over the years is shown in the Figure 2.1. Since

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[4] Cost recovery rate is simply the ratio of recoveries to the cost of providing the service.

data on the costs of various types of services is not available, recovery rates as percentages of total user fees collection is calculated from each stratum of the consumers. The Table 2.5 gives the collection of user fees according to different categories

Table 2.5
Cost recovery from different patient categories

Category (1)	No. of Patients (2)	Patient days (3)	Total recovery (4)	(4)/(2) = (5)	(4)/(3) (6)	% to total of (4) (7)
A	16	156	245	15.31	1.57	0.02
B	17	230	133446	7849.77	580.20	9.48
B1	36	451	182403	5066.75	404.44	12.96
C	3	39	7878	2626.00	202.00	0.56
D	44	417	1083106	24616.05	2597.38	76.98
Total	116	1293	1407078	12129.98	1088.23	100.00

Source: Compiled from the sample.

The cost recovery rate is higher from the Grid 'D' category which accounts for nearly three-fourth of total recovery. The recovery rate from Grid 'A' and 'C' is negligible with less than one per cent.

2.8 Subsidy allotment:

The SCT hospital mainly draws its funds from central government subsidies. As in the case of all other public hospitals, the subsidy element continues to be the major source of its financial resources. The percentage share of subsidy in total revenue receipts of the hospital is shown in Table 2.6.

The Table 2.6 shows a shift in the relative share of different components of revenue. This may be attributed to two reasons, namely, an increase in the relative amount of collection of user charges and the stagnancy of the government subsidy. Although the government subsidy had increased in nominal terms, it registered a decline in the real terms. Hence, the increase in the share of user charges needs a special mention.

Table 2.6

Share of subsidy in total revenue receipts

Year	Contribution to total revenue		Total
	Subsidy (%)	User charge (%)	
1981/82	86	13	99
1982/83	87	12	99
1983/84	82	18	100
1984/85	78	22	100
1985/86	79	21	100
1986/87	79	21	100
1987/88	78	22	100
1988/89	76	24	100
1989/90	76	24	100
1990/91	74	26	100
1991/92	66	34	100

Note : The discrepancy between total revenue receipts and the sum of subsidy and user charges is made up of other receipts such as income from agricultural sources, sundry receipts etc.

Source: Accounts Department of SCT hospital.

It was observed that there existed differentials in the recovery rate across different categories (see Table 2.5), however, the overall recovery rate has registered an increase. This has been facilitated by two deliberate attempts. First, in 1991, the hospital hiked the user fees from its earlier low levels. Second, the hospital administrators had taken a deliberate phased strategy of bringing down the number of patients admitted in the non paying category. Consequently, there is a spectacular increase in the percentage of paying patients whose share went up from 50 per cent in 1977 to 90 per cent by 1992/93. This is actually above the target envisaged[5]. Though the attempt at reducing the number of non paying patients started in 1982/83, it has become more pronounced by 1990/91. This period coincides with the recent hike in hospital charges. As mentioned earlier, the reduction in the non paying patient category is made possible through the alternate provision given to the patients to skip the existing queue by moving on to a paying category.

Though the subsidy allotments are targeted to the poor patients, a considerable portion of its benefits goes to the patients with higher income. Around 61 per cent[6] of the subsidy allotments ultimately goes to benefit the paying category, namely, Grid 'B1', 'B', 'C' and 'D'. This shows that the equity consideration has not been a matter of great concern.

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[5] The target was to bring down the number of non paying patients (Grid 'A') to 20 per cent.

[6] This has been computed from the Statement of Accounts of the SCT Hospital.

Chapter III

COST STRUCTURE ANALYSIS OF SCT HOSPITAL

In the health sector, given the nature of the product, a market clearing price may not exist as its demand is inelastic with respect to price[1]. Moreover, the health sector markets are physician dominant (Redisch, Gabel and Blaxall, 1981; Redisch, 1978). Implicit in it is the assumption that there are no dearth of demand for health services and that the price at which providers can supply services efficiently is important. The pricing of the services should, therefore, begin with the analysis of the costs. This chapter develops such a framework for the analysis of cost structure of SCT hospital.

An outline of the chapter is as follows: Section 1 discusses the theory of multi-product cost functions; Section 2 deals with the specification of cost function; Section 3 details the issues related to the measurement of output and input in the health sector; and, Section 4 presents the empirical results of cost function.

3.1 Theory of multi-product cost functions:

For a single product, the cost function is obtained by minimising cost subject to input prices and output[2]. Specifically,

$$\min C = \sum_{i=1}^{n} W_i X_i \quad \text{subject to } f(X) = q \qquad \text{-------} \ (1)$$

---

[1] Empirical studies, for instance Avinchey and Yannapoulos 1993, shows inelastic price elasticities of demand for health services.

where W is the vector of prices of n inputs represented by the vector X and q is the output. Optimising (1) yields the cost function C = c (W,q).

Baumol, Panzar and Willig (1982) extended this framework to the case of multiproduct firms. Given the heterogeneous nature of services provided by hospitals, analysis of their cost structure fits into the multiproduct framework. The specification and the peculiarities of a multiproduct cost function are, therefore, discussed below.

In the case of multiproduct firm, given a vector of parametric input prices W > 0, the multiproduct cost function can be defined as;

$$C^* (Q, W) = \min_X \{W.X / (X, Q) \in T\} = W.X^* (Q, W)$$

Here X^* (Q, W) is some vector of input levels that minimises the cost of producing the vector of output, Q at input prices W, and T is the production possibility set, which is a list of possible combinations of inputs and outputs (Baumol, Panzar and Willig 1982).

The multiproduct cost function should satisfies certain regularity conditions. The function is function that is positive for positive outputs, weakly increasing in output quantities and input prices, and satisfies C(0) = 0.

Since the multiproduct cost function is the primary analytic construct, it is useful to impose some additional properties upon it, that is; for all i, $Q_i > 0$, C (Q, W) has a partial derivative with respect to Q_i denoted by C_i implying that a marginal cost exists for any output whenever the quantity of that output is positive.

3.1.1 Cost concepts related to multiproduct cases:

An understanding of concepts such as economies of scope, economies of scale and Ray scale economies helps to study the cost and production characteristics of multiproduct firms.

Economies of scope: denotes the cost savings resulting from a simultaneous production of different outputs by a single firm, as against their production in isolation by individual firms. That is, there may exist economies resulting from the scope of the firms' operation. Formally, economies of scope can be interpreted as a restricted form of subadditivity[3]. The degree of economies of scope is defined as

$$SC_T\ (Q) = [C(Q1,\ 0) + C(0,\ Q2) - C(Q)]\ /\ C(Q)$$

where C(Q1, 0) and C(0, Q2) represents the separate costs of producing Q1 and Q2 units of outputs and C(Q) represents the joint

[3] Subadditivity is a necessary and sufficient condition for the existence of multiproduct firms. Subadditivity is said to exist if $C(Q_1,\ Q_2) < \{C\ (Q_1, 0) + C(0,\ Q_2)\}$. If subadditivity exists, any market structure involving specialty firms would be unstable in that it would be profitable for them to merge. If the opposite inequality held, no arrangement involving multiproduct firms could be stable because separation would be profitable. In the equality case, it becomes a matter of indifference.

cost of production. Thus, the degree of economies of scope measures the relative increase in cost that would result from dividing the production set Q into product lines Q1 and Q2. Such a fragmentation of the firm increases, decreases, or leaves unchanged the total cost, if SC_T is greater than, less than, or equal to zero, respectively.

Economies of scale: The degree of scale economies specific to product i is measured by the ratio of the average incremental cost[4] of the product to its marginal cost. Thus, the degree of scale economies specific to product Q_i at output vector Q is given by

$$Si(Q) = IC_i(Q)/Q_iC_i = AIC_i \ / \ (\delta C_i / \ \delta Q_i)$$

Returns to scale of product i are said to be increasing, decreasing or constant as $S_i(Q)$ is greater than, less than, or equal to unity, respectively. If the marginal cost is less than the average incremental cost, as is true by definition when $[S_i(Q) > 1]$, the latter has a negative derivative and will decline as Q_i increases.

Ray scale economies (RSE) represents the overall scale economies. It is obtained as

[4] Incremental cost of the product Q_i belonging to present set N at output vector Q is

$$ICi \ (Q) = C(Q) - C(Q_{N-i})$$

where Q_{N-i} is a vector with a zero component in place of Q_i and its components equal to those of Q for the remaining products. i.e. it is the firm's total cost with the given vector of output, minus what that total cost would be if one good i were abandoned, all other output quantities remaining unchanged. The average incremental cost of product i

$$AIC_i(Q) = IC_i(Q) \ / \ Q_i$$

$$RSE = C(Q) / \Sigma QiMCi$$

A value of RSE > 1 implies that an equal proportionate expansion of output will lead to substantially lower costs. If RSE < 1, the opposite happens and if RSE = 1, it implies that a given proportionate increase in output will lead to the same proportionate increase in costs[5].

3.2 Specification of the cost function:

For the present study, a translog function is used to represent the multiproduct cost function. The choice of a translog cost function is specifically due to the following reasons. Since the functional form of the production function relevant to the hospital is unknown, there are chances of misspecification. A way to circumvent this problem is provided by any of the flexible functional forms, which represent a local second-order Taylor approximation to any twice differentiable function so that restrictive assumption like separability can be dispensed with (Breyer, 1987).

It becomes obvious that the increased flexibility is gained at a cost; the number of parameters to be estimated grows almost proportionately to the square of the number `n' of original regressors. This is a particularly serious impediment to the estimation of multiproduct cost functions when the sample size is small. Therefore, some theoretical restrictions are imposed to reduce the number of parameters.

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[5] Alternatively the overall economies of scale can be obtained as RSE = 1 - Ec(q1) - Ec(q2), where Ec(q1) and Ec(q2) refers to the cost elasticities associated with outputs.

3.2.1 The translog model:

The translog function, a contraction of transcendental logarithmic function[6], belongs to the class of flexible functional forms. In CES and Cobb-Douglas functions the elasticity of scale are fixed. That is to say, if the elasticity of scale was 'n' for one level of output and one factor combination, then it will be 'n ' for all levels of output and all factor combinations. In translog function, the elasticity of scale (e) change with output and/or factor proportions.

For a two output-two input system, the specification of a translog cost function becomes:

$$\begin{aligned} \ln C = {} & \alpha_0 + \alpha_1 \ln q_1 + \alpha_2 \ln q_2 + \alpha_3 \ln q_1^2 + \alpha_4 \ln q_2^2 + \\ & 2\alpha_5 \ln q_1 \ln q_2 + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_1^2 + \beta_4 \ln P_2^2 \\ & + 2\beta_5 \ln P_1 \ln P_2 + \delta_1 \ln q_1 \ln P_1 + \delta_2 \ln q_2 \ln P_1 + \\ & \delta_3 \ln q_1 \ln P_2 + \delta_4 \ln q_2 \ln P_2 \end{aligned} \qquad (3.1)$$

where q_1 and q_2 refers to the outputs, P_1 and P_2 refers to the input prices and α's, ß's and δ's are the parameters.

Imposing restrictions on the cost function like homogeneity in input prices and constant returns to scale, it is possible to reduce[7] the number of parameters in the model.

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[6] Transcendental means non-algebraic and logarithmic functions are one form of transcendental functions.

[7] This is needed because the total number of observations available from SCT hospital is only 17. Therefore, by estimating the original translog model, the degree of freedom will be reduced to 2.

In order to impose homogeneity, consider the total differential of equation of (3.1) and allow only input prices to vary,

$$\frac{dC}{C} = \beta_1\frac{dP_1}{P_1}+\beta_2\frac{dP_2}{P_2}+$$
$$2\beta_3 lnP_1\frac{dP_1}{P_1}+2\beta_4 lnP_2\frac{dP_2}{P_2}+$$
$$2\beta_5 lnP_2\frac{dP_1}{P_1}+2\beta_5 lnP_1\frac{dP_2}{P_2}+$$
$$\delta_1 lnq_1\frac{dP_1}{P_1}+\delta_2 lnq_2\frac{dP_1}{P_1}+$$
$$\delta_3 lnq_1\frac{dP_2}{P_2}+\delta_4 lnq_2\frac{dP_2}{P_2}+ \qquad \text{-------}(3.2)$$

Homogeinty implies;

$$\frac{dP_1}{P_1} = \frac{dP_2}{P_2} = \frac{dP}{P} \qquad \text{--------}(3.3)$$

We get,

$$\frac{\frac{dC}{C}}{\frac{dP}{P}} = (\beta_1+\beta_2)+2\beta_3 lnP_1+$$
$$2\beta_4 lnP_2+2\beta_5 lnP_2+2\beta_5 lnP_1+$$
$$\delta_1 lnq_1+\delta_2 lnq_2+\delta_3 lnq_1+\delta_4 lnq_2 \qquad \text{--------}(3.4)$$

Rearranging terms

$$= (\beta_1+\beta_2)+2\beta_3 lnP_1+2\beta_4 lnP_2+2\beta_5(lnP_1+lnP_2)+$$
$$(\delta_1+\delta_3)lnq_1+(\delta_2+\delta_4)lnq_2 \qquad \text{--------}(3.5)$$

Hence, homogeneity requires the following restrictions on the parameters

$$\beta_1+\beta_2 = 1$$
$$\delta_1+\delta_3 = 0$$
$$\delta_2+\delta_4 = 0$$
$$\beta_3+\beta_5 = 0$$
$$\beta_4+\beta_5 = 0$$
----- (3.6)

Substituting (3.6) in (3.1), the translog function becomes;

$$lnC = \ln\alpha_0+\alpha_1 lnq_1+\alpha_2 lnq_2+\alpha_3 (lnq_1)^2+ \alpha_4 (lnq_2)^2+2\alpha_5 lnq_1 lnq_2+\beta_1 lnP_1+(1-\beta_1) lnP_2+ \beta_3 (lnP_1)^2+\beta_3 (lnP_2)^2-2\beta_3 lnP_1 lnP_2+\delta_1 lnq_1 lnP_1+ \delta_2 lnq_2 lnP_1-\delta_1 lnq_1 lnP_2-\delta_2 lnq_2 lnP_2 \quad \text{----- (3.7)}$$

On rearranging terms

$$lnC = \ln\alpha_0+\alpha_1 lnq_1+\alpha_2 lnq_2+\alpha_3 (lnq_1)^2+ \alpha_4 (lnq_2)^2+\alpha_5 lnq_1 lnq_2+\beta_1 \ln\frac{P_1}{P_2}+ \beta_3 (lnP_1^2+lnP_2^2-2lnP_1 lnP_2)+ \delta_1 (lnq_1 lnP_1-lnq_1 lnP_2)+ \delta_2 (lnq_2 lnP_1-lnq_2 lnP_2)$$
------------- (3.8)

Constant returns to scale implies

$$\alpha_1+\alpha_2 = 1$$
$$\alpha_3 = \alpha_4 = \alpha_5 = \delta_1 = \delta_2 = 0 \quad \text{------------ (3.9)}$$

Substituting (3.9) in (3.8) gives

$$lnC = \ln\alpha_0+\alpha_1 lnq_1+(1-\alpha_1) lnq_2+\beta_1 \ln\frac{P_1}{P_2}+ lnP_2+\beta_3 (ln\frac{P_1}{P_2})^2 \quad \text{----------- (3.10)}$$

The above restrictions have reduced the number of parameters from fifteen to six. Though the flexibility of this model has been restricted, the model is capable of explaining the variations in total variable cost due to the variations in input prices and output quantities.

3.3 Estimation of the cost function:

Estimation of cost function in the health sector confronts a number of problems. These can be analysed under three heads; (1) output measurement (2) definition of input prices and (3) definition of cost and its components.

3.3.1 Measurement of output:

Unlike the cases of industrial and agricultural output, it is difficult to measure the output of health sector, as the concept of output is ambiguous. Provision of health services aims at improving the patient's health, the outcome of which is difficult to measure accurately. However, output, being a crucial variable for the estimation of cost, needs to be measured. Breyer (1987) argues that given the ambiguous nature of the concept of output in health sector, it is essential to identify the level of easily observable intermediate products and use them as proxies for output. These proxies for output may be in terms of either total number of patients admitted or the total number of bed days occupied by patients. These are called unit case and patient days respectively.

In the literature, the unit case approach has been used more than the patient days approach because of two major reasons. First, it is more closely related to the true output, that is, health improvement than that of the patient days. And second, under the patient day approach, length of stay can be easily influenced by the hospital rendering the patient days an endogenous output variable. This violates an important property of cost functions[8]. Adoption of the unit case approach overcomes this problem.

Although the unit case approach is widely used for empirical purpose, it may not be an appropriate method of measurement of output for the given case of the study. This approach assumes away the differences in case mix, length of stay and severity of the ailment, the factors which have an important bearing on the cost incurred for cure. The unit case approach overcomes the problem of the length of stay becoming endogenous variable. The study does not concern with a cross-section of hospitals and, therefore, the length of stay does not becomes an endogenous variable. And to account for the complexity and intensity of the case, the patient days rather than the number of patients becomes important. Thus, the patient day approach becomes the better alternative.

However, this approach is not devoid of limitations. Following this approach would not help to account the outpatient services. The only possibility to overcome this problem is to ascertain the number of outpatient visits. The cost of a day of inpatient stay is influenced by the department which admits the patients, for example, the cost of inpatient day for Cardiac Surgery is more than any other department. Thus, while taking inpatient day, the intensity and complexity of the ailment should be considered. This is possible through weighting the bed days in each department with

---

[8] The problem of output becoming endogenous to the model has been discussed by Baumol, Panzar and Willig (1982) and Breyer (1987).

the amount of their share in fixed capital. In the context of SCT hospital, this need not be attempted because the services provided in the hospital more identical than that in general hospitals. The differences in case mix, is hence, assumed away. Thus, in the specification of the cost function for SCT hospital, a non-weighted inpatient day has been used as a measure of output.

Based on the above considerations, the cost function for SCT hospital may be specified. To start with, the analysis may be on a short-run multi product (variable) cost function defined as

$$C^V = a(q1, q2, P1, P2)$$

where q1 and q2 represents the outputs (the total number of bed days) in medical and surgical departments respectively, and P1 and P2 represents the respective variable input prices related to the two categories of inputs identified such as non-wage and wage. This cost function assumes that hospitals minimise (variable) costs, given the exogenous input prices and patient's demands for hospital services[9] and fixed capital inputs.

3.3.2 *Input prices*:

For the purpose of analysis, two broad categories of input prices[10] have been identified, namely, average wages and salaries of SCT employees and non-wage input prices such as drugs, utilities and materials.

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[9] For a theoretical discussion of the properties of a restricted variable cost, see Varian HR (1978)

[10] The classification of input prices is given in the Appendix 1.

3.4 Empirical Results:

Based on the nature of cost and output related to SCT hospital, cost function, as given in equation (3.10), is redefined as

$$lnC = \ln\alpha_0+\alpha_1 lnq_1+(1-\alpha_1)lnq_2+lnP_2+\alpha_2\ln\left(\frac{P_1}{P_2}\right)+\alpha_3\left\{\ln\left(\frac{P_1}{P_2}\right)\right\}^2$$

As in the equation (3.10), 'q1' and 'q2' have been used to represent two outputs, namely, the number of in patient days in medical and surgical departments respectively[11], C represents the total inpatient cost on hospital services, and P1 and P2 represents two input prices for non-wage and wage respectively[12].

The cost function was estimated for the period from 1976-'77 to 1992-'93, with the assumption that 30 per cent of the total variable cost is incurred on outpatient services[13] and this was deducted to obtain the cost incurred for inpatient services.

---

[11] The output in medical department is defined to include the total number of bed days in Cardiology and Neurology departments whereas the output of surgical department includes the total number of beds days in the Cardiac Surgery, Neuro Surgery, Thoracic Surgery and Radiology departments.

[12] P1 is the index of the non-wage input prices (medicines, utilities, materials and maintenance) and P2 is average annual wages and salaries of the employees.

[13] This is obtained by following the methodology as mentioned under the methodology section of Chapter I.

As in the literature[14], estimation of this model could be done through the Seemingly Unrelated Regression Estimation (SURE) which calls for the estimation of fifteen parameters to specify the function in terms of translog. However, following these a meaningful result cannot be obtained due to the limited number of observations.

The empirical framework followed proceeds in two steps. As a first step, a theoretical translog model without incorporating the restriction ($\alpha1 + \alpha2 = 1$) is estimated. The next step is to estimate the restricted translog function. The obtained regression results are given below. The figures in the parentheses, as given in every equations, are the 't' values.

The function estimated, without imposing the theoretical restriction $\alpha1 + \alpha2 = 1$, becomes[15]

---

[14] Fournier and Mitchell (1993) used a Non Linear Sure Estimation whereas Cowing and Holtmann (1983) used a system approach using maximum likelihood estimation.

[15] In the initial years, the output of the surgery department was found to be zero. Though there were cases of surgery handled during those years, they were treated as part of the medical departments. As the translog cost function was used, the presence of zero values poses problems in estimation, for the logarithm of zero is minus infinity. Hence, a very small positive number, 1, is introduced to substitute the zero values. In the proceeding analysis, two other variants of the model is also attempted with values 0.01, 0.1. Alternative to this is the Box-Cox transformation suggested by Caves, Christenson and Swanson (1980).

$$
\begin{aligned}
lnC = & -23.03 + 0.009\,lnq_1 + 0.129\,lnq_2 + 2.43\,lnP_2 - \\
& \;(0.96) \quad (0.71) \qquad (1.89) \qquad (10.95) \\
& 7.96\ln\frac{P_1}{P_2} - 1.11\ln\left(\frac{P_1}{P_2}\right) \text{ -- } (3.11') \\
& \quad (0.69) \qquad\qquad (0.83) \\
& R^2 = 0.99, DW = 2.28, N \cdot 17, F = 340.7 \\
& \text{-------- } (3.11)
\end{aligned}
$$

The regression result shows that only the average wages and salaries, P2, is significant. As postulated in the theoretical model, the restriction, $\alpha_1 + \alpha_2 = 1$, is imposed on the estimated regression equation (3.11). The result is

$$
\begin{aligned}
lnC = & -199.43 + 0.067\,lnq_1 + 0.933\,lnq_2 + 0.59\,lnP_2 + \\
& \;(2.94) \quad (1.53) \qquad (21.36) \qquad (1.02) \\
& -94.04\ln\frac{P_1}{P_2} + -11.014\ln\left(\frac{P_1}{P_2}\right)^2 \\
& \quad (2.90) \qquad\qquad (2.93) \\
& R^2 = 0.87,\ DW = 1.79,\ n = 17,\ F(1,\ 11) = 143.54 \text{ --- } (3.12)
\end{aligned}
$$

In the restricted regression (equation 3.12) variables such as q2, P1/P2 and $(P1/P2)^2$ are significant at 1 per cent level, q1 is significant at 15 per cent level and P2[16] is insignificant. Thus, the imposed restriction reiterates the theoretical assumption of constant returns to scale[17]. Since the function shows a better fit, in the initial years, the surgery output was found to be zero. To accommodate the zero values of output, three alternatives were tried. These three variants of the model corresponds to ei = 0.01, ei = 0.1 and ei = 1 ; where ei = qi, when qi =0. Table 3.1 maps out the results obtained from these three variants of the model.

---

[16] Recall that P2 was significant in the unrestricted model.

[17] An empirical examination of returns to scale is undertaken in the next section.

Table 3.1
Parameter estimates from multiproduct translog cost function

Variables	Parameters	e = 0.01		e = 0.1		e = 1	
		estimate	t-ratio	estimate	t-ratio	estimate	t-ratio
Intercept	lnα0	- 206.45	2.95*	-204.34	2.94*	-199.43	2.94*
q1	α1	0.042	1.34	0.052	1.43	0.068	1.53
q2	α2	0.958	30.72 *	0.947	25.92*	0.933	21.36*
P2		0.668	1.09	0.643	1.07	0.587	1.02
P1/P2	α3	-96.98	2.89*	-96.09	2.89*	-94.045	2.90*
(P1/P2)2	α4	-11.36	2.92*	-11.25	2.92*	-11.014	2.93*
		$\bar{R}^2$=0.82; DW=1.80 N = 17 F = 152		$\bar{R}^2$= 0.82; DW=1.79 N = 17 F =149		$\bar{R}^2$=0.83; DW = 1.78 N = 17 F = 143.5	

Note: * indicates level of significance at 1 per cent.

It is seen in Table 3.1 that the surgical output q2 has the highest measured impact on the variable cost[18]. The estimated cost elasticities suggest that a 10 per cent increase in medical and surgical outputs would individually result in a 9.32 and 0.67 per cent increase in variable costs. Though the cost elasticity of surgical output is positive and significant, it is insignificant in the case of medical output. The higher cost elasticity of surgical departments reveals their increased requirement of resources more than medical departments.

Table 3.1 shows identical results using the three variants and hence, choosing a model should depend upon its advantage over other

[18] The variable cost includes operating expenses for patient care services and other operating expenses less tax and interest expenses.

models. The model with ei = 1 has an advantage over the other variants because it provides more meaningful mean value. In the other models, the mean values are largely reduced by the negative values attached to the logarithms of the ei values. As it will significantly affect the estimates of the cost measures, model with ei = 1 is chosen.

An analysis of the effect of input prices at a disaggregate level on the cost was not undertaken due to the limited number of observations.

3.4.1 Multiproduct cost measures:

Having set the multiproduct framework for analysis of cost function for SCT hospital[19], the economies of scale and ray scale economies[20] need to be estimated. Economies of scope in SCT hospital may result from the sharing of complementary resources such as administration, laboratories, diagnostic equipments, support staff etc. Economies of scale in this model reflects the percentage change in costs for a given percentage change in both medical and surgical outputs simultaneously. Ray scale economies in the context of SCT hospital refers to the overall scale

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[19] The multiproduct approach related to hospital cost functions has been carried out by Cowing and Holtmann (1983), Fournier and Mitchell (1993), Grannemann and others (1986). Using a system approach, Cowing and Holtmann brought out the significance of economies of scope and scale in the production of hospital services. Fournier and Mitchell, using a Non Linear Seemingly Unrelated Regression Estimate, arrived at similar results as that of Cowing and Holtmann. A major shortcoming in Fournier and Mitchell is the use of the aggregative unit case rather than the more feasible method of patient days as units of hospital output. Grannemann and others ignored the theory of cost and choose an adhoc polynomial specification.

[20] Section 3.1.2 deals with the specification of economies of scope, economies of scale and Ray scale economies.

economies, associated with the medical and surgical outputs. The economies of scope, economies of scale and Ray scale economies, are calculated using the mean values of the variables[21]. The estimated values are given in Table 3.2.

Table 3.2
Economies of scope, economies of scale and Ray scale economies of SCT hospital

	e = 1
Degree of Economies of Scope	0.41
Product Specific Economies of Scale	
Medical	0.067
Surgical	0.932
Ray Scale Economies	1.00

The economies of scope, as a measure of cost effectiveness, shows a positive value, indicating that the joint provision of medical and surgical services in the same hospital is economically viable. The positive value for economies of scope points out the further scope of expansion of output in SCT hospital. Further, it substantiates the argument that combining two or more product lines will give rise to economies.

[21] The mean values, along with other descriptive statistics, is shows as follows

Variables	Mean	Standard Deviation	Maximum Value	Minimum Value
lnC	16.39588	1.04596	17.77411	14.49832
lnq1	9.82728	0.64858	10.11994	7.34057
lnq2	6.57456	5.00965	10.37746	0.0000

The estimate of the Ray scale economies, being equal to one, is due to the assumption of constant returns to scale. Within the analysis of economies of scale, to discern the short-run effects of varying an output while other output remains constant, the product specific economies of scale is used[22]. The estimated values of the product specific economies of scale related to both medical and surgical outputs in SCT hospital is less than one, implying that the average incremental cost is less than the marginal cost, the changes in outputs affect costs. The respective product specific economies of scale for the surgical and medical output are 0.93 and 0.07. It implies that the increase in surgical output will have a greater impact on the cost than the increases in medical output. This is because of the higher cost elasticity of surgical output.

To sum up:

Estimates of the inpatient cost in the SCT hospital in a multiproduct framework, using a translog cost function, shows the presence of economies of scope. The estimates validate the theoretical assumption of constant returns to scale. Empirical estimation of marginal costs will enable to proceed with pricing of health services which is taken up in the next chapter.

[22] Product economies of scale is defined as a ratio of average incremental cost (AIC) to marginal cost (MC).

Appendix 1

The study covers the period from 1976/77 to 1992/93. Though the hospital was started in 1973, the proper series of data as required for the study is available from 1976/77 and, hence, the study period begins from that year.

***Cost classification for the health sector*:**

The classification of cost into fixed and variable will not capture all the cost heads in the health services. It calls for analysing cost in a broader perspective. A widely accepted way of classification of cost in the health sector is to categorize cost into capital costs and operating costs (DeFerranti, 1985, Green, 1992). Operating costs includes those costs directly attributable in the production process, connoting the variable cost. The concept of capital cost encompasses the fixed cost. There are certain costs which change with the changes in output, but cannot be attached or identified to any single output, as they are spread in the different products (services) produced in a multiproduct (service) system. These costs are called common costs. Panzar and Willig (1981) has classified them as 'Shared input costs[23]'. Hence, the total cost in the hospital is the sum of the costs directly attributable to each departments plus the common costs inclusive of fixed cost. In the case of multiproduct firms, it is practically very difficult to arrive at a separate cost measurement for the different services provided. Many services are inter

[23] Shared inputs are those which, once procured for the production of one output, would be also available (either wholly or in part) to aid in the production of other outputs. Examples of sharable inputs might include elements of productive capacity (such as electric power generation or transmission facilities), indivisible equipment like factory building etc..

linked and the cost function for each of these separate services cannot be clearly ascertained. This is due to presence of economies of scale and scope.

The components of total variable cost and the indices of input prices used are shown below. The Inputs for which corresponding price indices are not available are excluded from the definition of total cost. The share of these inputs was around 9 per cent of total cost.

The classification of input prices:

a. **Wage:** The average annual salary of the employees in SCT is taken as the second input price. This is obtained by the following procedure. The expense incurred for the employees under the following heads have been aggregated to obtain the total wage bill: (1) Wages and salaries (2) Honorarium to Visiting doctors (3) Leave salary & Pension Contribution (4) Medical benefit to staff (5) Contribution to provident fund (6) Travelling expenses (7) Expenses for visiting Faculties (8) Home travel and Leave travel concession (9) Group Gratuity Insurance (10) Bonus & Festival allowances (11) Recruitment expenses (12) Staff training expenses (13) Contribution to pension fund and (14) Audit fee for each year. The total number of employees for the year 1992/93 is available. From this, a measure has been estimated: the ratio of total number patients - the sum of admission, new cases and repeat cases- to total number of employees. Assuming the same ratio to hold good, the number of employees were estimated over the years. These figures were used to obtain the average annual salaries by dividing it with the total wage bill of each year.

b. Non-wage input prices: The non-wage price was taken as a weighted average of several non-wage input prices. Since input prices were not directly available, suitable wholesale price indices, as presented below, were used as proxy for these input prices.

Items	Price Index
Medicine	Drugs and Medicines
Chemicals	Chemicals and Chemical Pdts.
Medical Gases	Oxygen
Films & Chemicals for X-ray unit	Cellulosic and Moisture proof films
Uniforms & Hospital Linen	Cotton Cloth (mill)
Inpatient Diet	Food Articles
Laboratory Expenses	Constructed[24]
Electricity & Water charges	Electricity
Repairs & Maintenance of Equipments	Machinery and Machine tools
'' of Buildings	Building materials
Tools, Glassware and Instruments used	Machine Tools

Excepting laboratory expenses, wholesale price indices from the India Database were used to represent all other input prices with base 1970/71 = 100. For laboratory expenses, since the total number of laboratory investigations done in each year and the total bill on laboratory expenses was known, a unit price index for laboratory investigations was estimated. A combined weighted average of these input price indices were taken (the rest of the inputs for which no separate index was available, were excluded from total cost), the annual expense on each item being the weights.

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[24] Index constructed from the unit investigation expenses.

Chapter IV

PRICING THE SERVICES: AN EXPLORATORY ANALYSIS

In this chapter, an attempt is made to arrive at a pricing solution for the services based on the estimated cost function given in the preceding chapter. The outline of the chapter is as follows: Section 1 briefly surveys the relevant literature, Section 2 develops a methodology for pricing the health services, Section 3 presents the estimates of the theoretical model and these estimates are used for the pricing solution in Section 4 and the last Section deals with a comparison of the estimated and the existing rate structures.

4.1 Multiproduct pricing:

The public utility pricing theories discussed earlier do not specifically address the issue of multiproduct pricing. However, theoretically, the Ramsey pricing model can be replicated in multiproduct situations. The estimation of Ramsey pricing model becomes difficult in the health sector because the price elasticity of demand for health care is very close to zero. Hence, pricing tends to be indeterminate.

Other conventional public utility pricing theories also do not incorporate effects of complementarity and substitutability. However, a model for the purpose at hand should effectively accommodate the features of a multiproduct firm. In this context, the optimal multiproduct tariff formulated by Wilson (1993) becomes relevant. It is a procedure of optimal pricing for multiproduct institutions accommodating the presence of economies of scope and scale. At the outset, it should be mentioned that it is possible to arrive at pricing solutions using a cost based approach.

4.2 The optimal multiproduct tariff:

Wilson details methods of non-linear pricing related to public utilities, approaching the problem from a demand profile[1] analysis. Given the nature of the output in the present case, a demand profile analysis does not assume much relevance. Hence, a cost function of the following form is used to arrive at a pricing solution[2].

$$C(q) = C_0+\Sigma_i\int_0^{qi} c_i(x_i)\,dx_i + \int_0^{q2}\int_0^{q1}\tau(x)\,dx1dx2$$

[1] The demand profile measures the number or fraction of the bivariate function N(p,q) of customers purchasing the q-th unit at the marginal price p.

[2] The solution to multiproduct pricing in terms of the demand profile analysis is as follows. Assuming a two output model, the tariff comprises a fixed fee P_0, a separate price schedule Pi(qi) for increments of each of the two products and a price differential π(q) that pertains to purchase of joint increments of both products. If these are included, then the tariff has the general form

$$P(q) = P_0+\sum_i\int_0^{qi} P_i(x_i)\,dx_i + \int_0^{q2} P_i(x_i)\,dx_i + \int_0^{q2}\int_0^{q1}\Pi(x)\,dx1dx2$$

and the total marginal price of, say product 1 is

$$P1(q) = P1(q1) + \int_0^{q2}\Pi(q1x2)\,dx2$$

for which marginal cost of product 1 is

$$c1(q) = c1(q1) + \int_0^{q2} \tau(q1, x2)\, dx2$$

In this scheme, C_0 represents fixed cost, $Ci(q)$ represents separate marginal cost of supplying the q_ith unit of product i, and cost differential $\tau(q)$ represents the cost of supplying unit increment in each product. Cost differential may also be viewed as the change in the marginal cost of supplying one product as the quantity of the other product increases. Thus, it incorporates effects due to economies of scope or substitution or complementarity in production. In this situation, pricing consists of three cost components, namely, fixed cost, marginal cost and cost differential.

4.2.1 Estimation of fixed cost:

The measurement of capital stock is a debated issue, enquiry of which falls beyond the scope of the present study. However, some relevant issues relating to the measurement of capital stock needs mention. Capital assets depreciate in value with the passage of time. Therefore, in the measurement of capital stock, suitable depreciation allowances have to be provided. Besides the conventional method of estimating the annual amount of depreciation by dividing the total cost of capital asset by its expected life span, there exist other methods[3]. The rate of depreciation, estimated using any of these different methods, can be used to estimate the real value of the capital asset.

The capital stock, in the estimation of fixed cost of SCT hospital, includes machinery, equipment and buildings. The expenses incurred on land also forms part of it. However, as the valuation of land enhances with time, it is not necessary to estimate its present value. The purchase value of these assets are available from 1973. The real value of these assets are obtained by deflating them by using appropriate price indices[4].

The life span of the hospital equipment and machinery is assumed to be 10 years[5]. For other assets such as buildings and lifts, the life span is treated as 50 years[6]. A rate of depreciation of 10 per cent is provided on residual value of these assets following declining balance method[7]. The capital assets of both medical and

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[3] The most widely-used ways of providing depreciation are; fixed instalment method, diminishing balance method and the annuity method.

[4] These indices are collected from the India Data Base. For machinery and equipment, the price index of machinery and machine tools is used. As for buildings, the price index of building materials is taken. The year 1970-71 is the base year for all these indices.

[5] The Accounts Department of SCT hospital treats the life span of medical equipment at 10 years and this has been followed in the present study.

[6] This is drawn from the suggestions of the Engineering Department of SCT hospital.

[7] Though depreciation leads to a depletion or diminution in the value of a fixed asset, value of assets get appreciated due to rising prices. Hence, after allowing for depreciation and converting into constant prices, an improvement element should also be added.

surgical departments were identified and measured separately along with the total c..ital assets. Such a two-way process of deflation and depreciation is expected to yield a true measure of the capital stock. The real values thus obtained are reported in Appendix 1. As mentioned, a life span of 10 years for capital equipment has been assumed. Assuming a total fixed cost of, say x, the annual recovery should be `x / 10', where `x' at any point of time includes the uncovered capital stock plus the annual additions. This assumes discrete increases in fixed capital though not necessarily annual. Further, it implies that 1/10 of the real value of capital assets is to be recouped each year by charging the patients. For recouping expenses on buildings, a similar method is followed with a recovery period of 50 years. As the sample survey showed that 30 per cent expenses are incurred on outpatients, the inpatient's contribution to the cost recovery need only be 70 per cent. From this total inpatient cost, the costs borne by medical and surgical departments have to be deducted and the balance is apportioned between the medical and surgical departments on the basis of the proportion of capital equipment used by these departments.

4.2.2 The estimation of marginal cost:

In Chapter III, a multiproduct translog cost function in output (in quantities) and input prices was estimated. From this, an estimate of the marginal cost of each output can be obtained by taking the partial derivative of the cost function with respect to each product. Thus, for instance, the marginal cost of medical output (q1) from equation (3.10) can be obtained as

$$MC_{q1} = \frac{\delta C}{\delta q1} = \frac{\alpha_1}{q1} C$$

With the assumption of constant returns to scale, the marginal costs from a restricted translog function becomes equivalent to the average cost (C/Q).

4.2.3. Estimation of cost differential:

As discussed, Wilson estimated a price differential from the demand profile. The procedure suggested by Wilson for the estimation of price differential could be recast in the form

$$\tau(q) = \frac{\delta^2 C(Q)}{\delta q_1 \delta q_2}$$

This measures the rate of change in the costs of each product with respect to the quantity of the other.

Since the translog cost specification in Chapter III does not contain cross product terms, the estimation of cost differential cannot be undertaken in this form. However, with the empirically valid assumption of constant returns to scale, the cost differential becomes zero. Hence, no attempt is made to estimate this cost component.

4.3 Empirical Estimation:

4.3.1 Recovering the fixed expenses:

The fixed cost calculated for the medical and surgical departments for the year 1992-93 are Rs. 8902151 and Rs. 10672637 respectively. Thus, the total capital stock for both departments is Rs. 19654550. Adding the cost of buildings and others, it amounts to Rs.

35443880. The share of medical department in the total cost is 46 per cent and that of surgical department is 54 per cent. Thus, the total amount to be recouped from each department works out to Rs. 16197892 and Rs. 19246419 respectively. Following the Gross Output Method of Fully Distributed Pricing[8], the amount per inpatient day in the medical department, with the assumption of 70 per cent cost recovery, is Rs. 48.51 and in surgical department, Rs. 42.86. Full cost recovery from the inpatients alone amounts to Rs. 69.31 and Rs. 61.24 respectively[9].

4.3.2 Estimation of marginal costs:

The marginal cost function is obtained as the first derivative of the total cost function with respect to the patient days. The expression for medical department is expressed as

$$MC_{q1} = \frac{\delta C}{\delta q1} = \frac{(0.0667)}{q1} C$$

Estimates of marginal costs for both medical and surgical output from the multiproduct translog model are presented in Table 4.1.

[8] This method is elaborated in Section 1.4 of Chapter I.

[9] See the Appendix 2 for details.

Table - 4.1
Marginal costs of patient days in medical and surgical departments

Departments	Marginal cost (Rs.)	
	At mean values	For 1992/93
Medical	64	121
Surgical	1312	1681

Note: The estimates are from the model using ei = 1

Mean values are that of total inpatient variable cost and the total patient days

The Table 4.1 shows a large difference between the marginal costs of the two departments. The higher marginal cost in the surgical department can be attributed to the high cost elasticity of surgical output[10].

From the above expression for marginal cost, it is evident that as hospital output increases, marginal cost will decline. This is more evident from the second derivative of the cost function which will yield a negative rate of change in marginal cost. The same results hold good for the marginal cost in surgical department as well. But, with the assumption of constant returns to scale and with its empirical validity in the present context, any given increase in both the output will lead to a proportionate increase in total variable cost, thereby making the marginal cost constant.

Based on the optimal multiproduct tariff model and its estimated components, the tariff rates can be arrived at. In this context,

[10] The high cost elasticity of surgical output has been discussed in the previous chapter.

two alternatives for pricing can be thought of; one with efficiency consideration and the other incorporating the objectives of efficiency and equity.

4.4 Pricing the Services:

As already mentioned, in this section, pricing with considerations of efficiency and equity are attemted.

4.4.1 Efficiency Pricing

Efficiency[11] pricing follows directly from the estimated theoretical model. With the assumption of constant returns to scale, the marginal costs of outputs which are obtained from the translog cost specification becomes analogous to the average cost. Hence, pricing at the marginal cost will automatically yield full recovery of the variable cost components. Recall that the fixed costs were excluded from the translog cost function specification. Going by the recent discussions on the full cost recovery mechanism in the health sector, it may be noted that the efficient prices shown in Table 4.2 allows for full recovery of variable and fixed cost. The alternatives in pricing with and without allowing for 30 per cent recovery from the outpatients is given in Table 4.2

[11] Efficiency is understood in the sense that the sum of consumer surplus and producer surplus should be maximum.

Table 4.2
Tariff rates based on efficiency pricing

(In Rs.)

	Marginal Cost Recovery		Fixed Cost Recovery		Total Cost Recovery	
	70%	100[12]%	70%	100%	70%	100%
Mean Values*						
1. Medical	64.73	92.47	48.04	68.64	112.77	161.14
2. Surgical	1312.09	1874.45	47.39	67.69	1359.48	1942.14
1992/93 Values**						
1. Medical	182.43	260.14	48.04	68.64	230.47	328.78
2. Surgical	2006.93	2867.05	47.39	67.69	2054.32	2934.74

Note : * Indicates estimates at mean values
** Indicates estimates at current values

100% recovery implies that the total cost is fully borne by the inpatients

Table 4. 2 reveals that the surgical departments warrants a higher charge as compared to the medical departments. The rate for surgical department works out to be around nine times higher than that for medical. A high price in surgical department clearly brings forth the nature of resource use in that department. Surgical care in hospitals requires more expenses especially when the patient is in the intensive care unit. A comparison of the existing rates with the estimated rates, which is attempted in section 4.4.1, is expected to provide more information on the estimated pricing solution.

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12. The regression equation corresponds to e = 1. The regression model is

$$\begin{aligned} lnC &= \underset{(2.94)}{-199.07} + \underset{(1.53)}{0.067}\, lnq_1 + \underset{(21.36)}{0.93}\, lnq_2 + \underset{(1.03)}{0.59}\, lnP_2 \\ &\quad \underset{(2.91)}{-94.04}\, \frac{lnP_1}{P_2} \underset{(2.93)}{-11.02} \left(\frac{lnP_1}{P_2}\right)^2 \qquad \text{------------(1)} \end{aligned}$$

$R^2 = 0.87$, $DW = 1.79$, $N = 17$.

Figures in parentheses are the 't' values.

4.4.2 Pricing for efficiency and equity

The collection of uniform charges from all income groups is not feasible in health sector. Health, treated as a right[13], should not be denied to people who do not have the potential to pay for the services. Therefore, setting any pricing policy should not deny any one access to medical facilities.

Moreover, to the extent people with low incomes spend on health care, they abstain from other forms of personal consumption. This abstainment might be a major cause for ill health which, in turn, imposes additional burden on the health sector. Hence, the need to subsidise those who cannot bear the burden of medical expense. The objective of cost recovery from within the sector calls for cross subsidisation. Cross subsidisation can be either between various services or between customer classes. The latter gains significance in the context of pricing with efficiency and equity.

The criteria for cross subsidisation used in the present study is based on the present system in the SCT hospital. The patients are classified under different income brackets such as A, B, B1, C and D. Prices should accordingly be fixed, taking into account, the ability to pay of each category.

Since, the complete free system is inefficient[14], a minimal payment should be imposed on category 'A' also. As one goes up in the

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[13] UNO treats health as a right of the individuals in its 'alma ata' declaration of 'Health for all by 2000 AD'.

[14] A complete free or zero price system will lead to greater wastage and lack of accountability on the part of both patients and providers of service.

ladder of income strata, the amount charged should be progressively higher[15]. However, this rule cannot be applied directly to the marginal cost component in the pricing solution. Any deviations of prices from the marginal cost solution will have its repercussion on economic efficiency (Brown and Sibley 1986). Therefore, the possibility of cross subsidisation is found only in terms of the fixed cost component.

The average expenses on fixed cost for a patient day is estimated to be Rs. 48.52 in medical department and Rs. 42.87 in surgical department. Based on this, a scaling mechanism is developed through which the equity consideration is given importance. The scaling mechanism is evolved in the following way. The number of patients in each category is multiplied with their mean income[16] and then the share of the income in a particular Grid as a proportion of the total income is estimated[17]. From this, the charges to be borne by each category of patients is calculated in such a way that the total cost is fully covered. The results thus obtained from the sample data are shown in Table 4.3.

[15] The approach towards taking income alone as the criteria for the assessment of ability and willingness to pay may be subject to criticism. However, being an exploratory exercise, the existing pattern of categorising patients in SCT hospital based on income brackets is followed.

[16] Since the mean income is not known, the lower limit of each Grid is used as a proxy.

[17] These results are obtained from the sample observations.

Table 4.3
Proportionate share of each category in total income

Category	Number of Patients	% of Patients	Number of Bed days	Size class (income)	Size of Income	Share in Income
A	16	13.79	156	250	4000	0.01
B	17	14.66	230	1500	25500	0.08
B1	36	31.03	451	2500	90000	0.29
C	3	2.59	39	4000	12000	0.04
D	44	37.93	417	4000	176000	0.57
Total	116	100	1293	-	307500	100

Note: Compiled from the sample

The Table 4.3 shows that out of the total income, the share of Grid A is only one per cent whereas for Grid D it is 57 per cent. Assuming that the capacity to pay depends on the size of income it should be argued that category D should pool in 57 per cent of the total fixed cost and category A, one per cent of the total cost. Based on this scaling mechanism, the calculated fixed cost component per patient day is recouped from each category of patients in such a way that the weighted average of this makes up the total fixed cost for each department. These results are shown in Table 4.4.

Table 4.4
Allocation of fixed cost between patient categories

Grid	No. of bed days		Share in cost 100%		Cost per bed 100%		Share in cost 70%		Cost per bed 70%	
	Med.	Sur.	Med.	Sur.	Med.	Sur.	Med.	Sur.	Med.	Sur.
A	2980	4008	19293	25586	6.47	6.38	13503	17913	4.53	4.47
B1	3167	4259	122995	163112	38.84	38.30	86082	114195	27.18	26.82
B	6706	9018	434099	575689	64.73	63.84	303819	403042	45.31	44.69
C	559	752	57880	76758	103.57	102.14	40509	53739	72.49	71.51
D	8196	11022	848906	1125791	103.57	102.14	594135	788170	72.49	71.51
Total	21608	29058	1483173	1966936	68.64	67.69	1038448	1377059	48.04	47.39

Note: Estimation based on table 4.3 and Appendix 4.2.

Therefore pricing rule with equity considerations could incorporate the concept of cross subsidisation in this manner. Since a cross subsidisation of this nature is not theoretically consistent, it is not attempted for marginal cost component.

4.5 Discussion of the results

The pricing solutions which are obtained from the estimated model can be compared to the existing charges prevailing in the SCT hospital.

Table 4.5
Existing rate structure in SCT hospital at current prices for the year 1992/93

Department	No. of patients	Bed days	Amount per patient	Amount per bed day
Medical	47	427	5237.4	586.39
Surgical	70	866	16524.14	1335.67
Total	117	1293	12026.3	1088.23

Source: Compiled from the sample

Table 4.6
Estimated rate structure at current prices for the year 1992/93

Depts.	No. of patien	Bed days	Amt. per Patient (100%)	Amt. per Bed day (100 %)	Amt. per Patient (70 %)	Amt. per Bed day (70 %)
Medical	2100	21608	2785.33	332.67	2105.51	232.86
Surgical	1941	29058	42989.23	2943.74	27817.63	2054.32
Total	4041	50666	21431.69	1723.90	15205.19	1207.13

Note: Estimated from the regression with ei = 0

There are certain interesting results which stems from the analysis. The estimated charges show that the prevailing charges are high for the medical departments. The amount charged per bed day at present in this department is Rs. 586.39 whereas the estimated charges are lower, even assuming full recovery from inpatients. In contrast to this, the estimated rate for surgical departments is Rs. 2054.32 per bed day whereas the existing rate is only Rs. 1335.67. The higher rate for surgery output clearly manifests the nature of resource use in that department[18].

To sum up:

The basic objectives of the study were the estimation of an efficiency pricing solution and a set of prices which accommodate equity considerations. The estimated model provides directly an efficiency solution. As regards fixed cost, a scaling mechanism was evolved to reduce the burden of fees on the lower income groups. The same scheme of scaling can be adopted to recover the marginal cost also, if efficiency is not considered. A possible alternative for this is to cover up the possible extra burden on high income groups through allocating the Central government subsidies. Since these issues need more theoretical reasoning, a detailed analysis of these aspects are not attempted here.

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[18] Recall that the estimated cost function excludes around 9 per cent of the input costs. If that is also included, the rates for both surgical and medical departments would still increase.

Appendix: 1

Deflated and depreciated value of capital assets in medical and surgical departments

	Index		Cost of Machinery and Equipment				The Deflated and Depreciated Value of						
							Machinery and Equipment in						
Year	Machine	Buildg.	Medical	Surgical	Others	Buildg.	Medical	Surgical	Others	Building	Total1	Total2	Total3
1972/73	110.80	114.50	0	640000	0	0	0	523388.94	0	0	523389	523388	523389
1973/74	122.28	123.80	480000	0	0	2500000	392542	471050.05	0	1874063	863592	863591	2737655
1974/75	147.40	133.40	0	0	0	0	353288	423945.04	0	1836582	777233	777232	2613814
1975/76	171.40	174.60	2760000	0	450000	0	1928227	381550.54	305292	1799850	2309778	2615069	4414919
1976/77	171.50	185.80	0	3790000	4850000	825000	1735404	2554597.35	3104401	2206212	4288712	7393113	9599326
1977/78	171.60	186.50	800000	0	100000	4592000	2028064	2299137.62	2852270	4468467	4326042	7178311	11646778
1978/79	179.20	199.10	0	0	100000	0	1825258	2069223.86	2625318	4379097	3893438	6518755	10897853
1979/80	204.10	233.90	0	0	0	0	1642732	1862301.47	2362786	4291515	3504094	5866879	10158395
1980/81	227.00	286.30	200000	0	0	2555577	1566565	1676071.32	2126507	5052464	3241790	5368297	10420761
1981/82	248.60	301.80	0	0	0	0	1409908	1508464.19	1913857	4951414	2917611	4831467	9782882
1982/83	264.60	367.10	0	0	0	0	1268917	1357617.77	1722471	4852386	2625850	4348321	9200707
1983/84	280.30	451.40	50000	6800000	660000	0	1159864	3647828.17	1799657	4755338	4807075	6606732	11362070
1984/85	292.50	492.20	0	0	0	0	1043877	3283045.35	1619691	4660231	4326368	5946059	10606290
1985/86	319.40	544.80	1000000	2700000	170000	9020000	1252577	3800075.82	1515842	6190789	5052153	6567994	12758784
1986/87	339.80	555.50	0	0	0	0	1127319	3420068.24	1364258	6066973	4546938	5911195	11978169
1987/88	353.70	560.20	30700000	0	20000000	0	9694259	3078061.41	7113647	5945634	12771916	19885563	25831197
1988/89	382.70	587.80	150000	270000	1100000	0	8764028	2840806.62	6713280	5826721	11604471	18317751	24144473
1989/90	421.78	657.40	18700000	2000000	350000	0	12321195	3030904.45	6133408	5710187	15351771	21485179	27195366
1990/91	457.31	737.22	0	0	100000	26000000	11089075	2727814.01	5543776	8891486	13816594	19360370	28251856
1991/92	528.62	788.95	0	0	1300000	3000000	9980168	2455032.61	5273669	9014336	12434935	17708603	26722939
1992-93	590.80	997.74	0	50000000	11677184	0	8982151	10672637.83	6955281	8834049	19654550	26609831	35443880

Source: RBI Bulletin (Various issues).
Statement of accounts, SCT.
Medical Records Department, SCT.

Appendix: 2

Share of medical and surgical departments in fixed cost under full and 70 per cent recovery from inpatients

							Total Cost				Building Cost				Total			
	Share in Total Cost		Share in Building Cost		Output		Recovery (1/10)		Recovery (1/10) of 70%		Recovery (1/10)		Recovery (1/10) of 70%		Recovery (1/10)		Recovery (1/10) of 70%	
Year	Med	Sur	Med	Sur	Med	Sur	Med	Sur	Med	Sur	Med	Sur	Med	Sur	Med	Sur	Med	Sur
1972/73	0	523389	0	0	0	0												
1973/74	1244389	1493266	851847	1022216	0	0												
1974/75	1188097	1425717	834810	1001772	0	0												
1975/76	3685622	729297	1502534	297316	0	0												
1976/77	3884316	5715010	892732	1313480	1541	0	228.2		159.7		11.2		7.8		239.4	0.0	167.6	0.0
1977/78	5460053	6186725	2094834	2373633	16875	0	30.1		21.0		2.5		1.7		32.5	0.0	22.8	0.0
1978/79	5108954	5788899	2052937	2326160	24833	0	18.4		12.9		1.6		1.1		20.0	0.0	14.0	0.0
1979/80	4762294	5396102	2011878	2279637	20107	0	21.1		14.8		2.0		1.4		23.1	0.0	16.2	0.0
1980/81	5035735	5385026	2441556	2610908	23000	0	19.8		13.9		2.1		1.5		21.9	0.0	15.3	0.0
1981/82	4727486	5055396	2392725	2558690	22000	0	19.2		13.4		2.1		1.5		21.3	0.0	14.9	0.0
1982/83	4446156	4754551	2344870	2507516	18346	15804	21.7	26.9	15.2	18.8	2.5	3.1	1.8	2.2	24.2	30.0	16.9	21.0
1983/84	2741470	8620600	1147380	3607958	19576	15488	11.7	52.6	8.2	36.8	1.1	4.6	0.8	3.2	12.9	57.2	9.0	40.0
1984/85	2559114	8047177	1124433	3535799	21327	21961	10.7	32.7	7.5	22.9	1.0	3.2	0.7	2.2	11.7	35.9	8.2	25.1
1985/86	3163276	9595508	1534878	4655911	23059	22000	12.6	40.0	8.8	28.0	1.3	4.2	0.9	2.9	13.9	44.1	9.7	30.9
1986/87	2969739	9008430	1504180	4562793	21563	22200	12.3	36.3	8.6	25.4	1.4	4.0	1.0	2.8	13.7	40.3	9.6	28.2
1987/88	19606637	6224560	4512911	1432723	25000	22700	77.2	23.5	54.1	16.4	3.6	1.2	2.5	0.8	80.8	24.6	56.6	17.2
1988/89	18234596	5909876	4400507	1426215	24000	23000	67.8	23.0	47.5	16.1	3.6	1.2	2.5	0.9	71.4	24.2	50.0	16.9
1989/90	21826758	5368608	4582945	1127242	26000	23500	76.9	20.3	53.9	14.2	3.5	0.9	2.4	0.7	80.4	21.3	56.3	14.9
1990/91	22674688	5577169	7136227	1755259	25000	24000	82.0	21.0	57.4	14.7	5.6	1.4	3.9	1.0	87.6	22.4	61.3	15.7
1991/92	21447592	5275347	7234825	1779510	23761	26667	80.7	17.7	56.5	12.4	6.0	1.3	4.2	0.9	86.7	19.0	60.7	13.3
1992-93	16197892	19245988	4037170	4796879	21608	29058	65.0	64.4	45.5	45.1	3.6	3.3	2.5	2.3	68.6	67.7	48.0	47.4

Source: RBI Bulletin (Various issues)
Statement of accounts, SCT.
Medical Records Department, SCT.

Note: Med - Medical Department.
Sur - Surgical Department.
Recovery (1/10) - Full recovery from inpatients.
Recovery (1/10) 70% - 70 per cent recovery from inpatients.

Chapter V

CONCLUDING OBSERVATIONS

The study focussed on pricing health services from theoretical and empirical perspectives. Absence of a market clearing price leads to economic inefficiencies. The excessive dependence of the health sector on government subsidies and the price inelasticity of health services also underlines the need for a proper pricing policy.

The study attempted a cost based approach to pricing. The demand for health services could not be estimated in the case discussed. Emphasis was laid on formulating a pricing rule which compensates for the costs involved in the provision of service rather than estimating the willingness to pay on the part of the consumers. Thus the study sought to estimate of a cost function for the provision of hospital services. Since hospitals are multi product, institutions, the cost analysis was carried out in a multi product framework. The steps involved in the estimation of the cost function were:

(1) The specification of a theoretical model based on a translog cost function.

(2) An empirical examination based on the theoretical model.

The translog cost function was selected arbitrarily. The flexibility of the function was the major factor which influenced the selection.

The multi product framework helped investigate short-run hospital characteristics like economies of scope, economies of scale and Ray scale economies. The empirical estimation showed the presence of economies of scope, indicating cost reductions from the joint provision of services. The theoretical assumption of constant returns to scale was found to be empirically valid. The estimates of multiproduct cost measures were found useful in the selection of an appropriate pricing strategy.

The pricing solution obtained with the estimated cost function, is dependent on the assumption of multi product hospital services. The optimal multiproduct pricing procedure is used for the pricing solution. The empirical estimates consisted of marginal cost and a fixed costs components. The estimated prices, when compared with the existing tariffs, revealed that the present system was not based on economic efficiency considerations. The current prices in the medical department was higher than efficient prices estimated In the surgical department the existing rates were below the efficient prices estimated. The question of equity was accommodated by incorporating a scaling mechanism to allow for cross subsidisation.

The pricing solution is restrictive, to a certain extent, because a disaggregated pricing solution for all the services could not be estimated. This is ascribed to the small sample size. But the empirical methodology developed in the study is valid for larger exercises. The inability to estimate a demand function for different services is another limitation which prevents a better understanding of the cost and pricing mechanism.

The study throws us crucial methodological issues that demand more detailed investigations. To suggest,

(1) the demand for health services are found to be price inelastic. Any pricing decision involves an analysis of the cost structure. This requires a proper specification of the multiproduct cost function.

(2) The applicability of the 'Ray average cost' method of analysing cost and a pricing rule based on it needs to be explored. In the Ray average cost framework, the relevance of alternative pricing strategies may be examined on the basis of the optimum point of the cost function. Similarly if the level of operation of the hospital is at the minimum point, the possibility of applying a marginal cost pricing policy also needs to be examined.

The pricing solution developed in the study is constrained in its empirical application on two counts. First, the assumption of constant returns to scale limits the flexibility of the model[1]. However the relaxation of the assumption may be useful in providing more flexible empirical applications of the model. Second, the pricing model is general in nature. It discusses the pricing solution for only two broad categories of hospital output namely medical and surgical. This fails to capture the actual resource use for different services across departments.

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[1] The assumption of constant returns to scale was, however found to hold good in this case.

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