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DEPARTMENT OF COMMUNITY HEALTH

DETERMINANTS OF HOSPITAL COST IN ADDIS ABABA

BY

ABDULELETIF MOHAMMED (MD)

ADVISOR: DAMEN H/MARIAM (MD, MPH, PHD)

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DEDICATION

To All My Families

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I have many debts of gratitude to acknowledge, first of all to The Creator of the universe.

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ABSTRACT

Background: The share of public sector health resources in developing countries consumed by hospitals ranges from 50 to 80 percent. Multiple constraints and expanding demands have revealed the limits of governments' reach and so reducing the role of the government, enhancing that of the private sector, or both, are policy questions based on the notion that private ownership entails mechanisms which promote economic efficiency. In order to promote economic efficiency and to decide which outputs are best delivered in hospitals and to examine the trade-offs between various services, it is helpful to know how hospital cost functions are influenced by output levels and other variables.

Objective: The objective of this study was to identify and estimate the effects of determinants of costs for a sample of government and private hospitals in Addis Ababa.

Methods: A cross sectional study was conducted from Jan 2007 – March 2007 in Addis Ababa with in purposively selected hospitals. All facilities with complete information on the study variables for the financial years 2003-2005 were considered. This gave a sample of 30 hospitals generating 41 observations for assessing the determinants of costs. Interview with key informants and document review were conducted. Translog – like cost function was specified and estimated using ordinary least squares (OLS).

Results: According to the results of the study number of beds and number laboratory tests done had a positive and statistically significant effect on total cost. The volume of outpatient activity, as measured by the number of first outpatient visits to the hospital had a statistically significant and negative impact on total cost. Calculated marginal costs had economies of scale for the number of first outpatient but had diseconomies of scale for the number of laboratory tests done. A negative and statistically significant coefficient associated with the interaction term for inpatient and outpatient output indicated the existence of economies of scope between the number of inpatients and the number of first outpatient visits.

Conclusion: The results of studies performed on hospital costs in Ethiopia are too limited to provide definitive guidance for policy. However, the estimated results imply that it is efficient to combine outpatient and inpatient care at the same facility and also it is more efficient to have one large hospital rather than two small ones. Additional empirical investigation is warranted

. INTRODUCTION

In most developing countries, the government has historically assumed the primary responsibility for financing and delivering health care. According to an earlier World Bank study of public hospitals, the share of public sector health resources in developing countries consumed by hospitals ranges from 50 to 80 percent. In Ethiopia the share is 49 percent (1). There is, however, widespread concern over the efficiency of public sector health services in developing countries. To some, the main problem is allocative efficiency: the distribution of resources between different health interventions and the over-provision of less cost-effective interventions. To others, the main problem is technical efficiency: for example the widespread waste of resources because of poor purchasing and distribution systems, and overstaffing (2).

Multiple constraints and expanding demands have revealed the limits of governments' reach and the consequences that these limits bring about. Reducing the role of the government, enhancing that of the private sector, or both, are policy questions that have come to the fore. This is based on the notion that private ownership entails mechanisms that promote economic efficiency, while public ownership lacks such mechanisms (3-5).

In order to promote economic efficiency and to decide which outputs is best delivered in hospitals and to examine the trade-offs between various services, it is necessary to know how hospital costs are influenced by types and levels of outputs and other variables.

The purpose of this study was to identify and analyze the determinants of hospital cost in Addis Ababa, Ethiopia, by conducting a case study using data from private and government hospitals.

2. LITERATURE REVIEW

2.1. What is hospital?

Hospital is defined as an institution in which sick or injured persons are received and treated (6). In economic terms, the defining characteristic of a hospital is the provision of inpatient treatment. The reason for this is that other types of output can be produced in institutions other than hospital. This should not be taken to imply that all health care institutions, which admit inpatients, are hospitals. In this context, the meaning of the term ‘‘treatment’’ requires amplification. Treatment is medical care aimed at curing illness or alleviating its symptoms, and not all health care institutions, which admit inpatients, provide treatment (7).

2.2. Hospital Outputs

People utilize hospital services because their health stocks have fallen below some critical levels, then, the restoration of the health stock of its patients, ought to be regarded as the outputs of hospitalization (8,9).

There are two main approaches for defining and measuring hospital output: one that uses "final outcomes" (or health outcomes or health status measures) and another that uses health output (services produced by the provider, such as number of discharges, patient days, number of deliveries, and so on). The use of health outcome as a measure of health provider activity is hindered by two problems. First, health outcomes are difficult to measure since they often require patient follow-up over the long periods of time during which recovery is expected to occur. Second, even if changes in health outcomes can be measured, it is difficult to discern which part of the changes is attributable to health care and which is due to other factors affecting health status.

The main problem faced by researchers employing [health output] measures is lack of homogeneity. The problem presents itself in a number of ways and for a variety of reasons. A patient day of care, for example, is likely to differ:

(a) between hospitals;

(b) between different departments of the same hospital;

(c) over time (both short term for a particular patient and in the longer term overall).

These differences may arise because of:

(a) changing technology;

(b) varying qualities of care;

(c) varying case-mix

(d) varying case complexity or case severity;

(e) varying institutional characteristics—size, teaching status, location, composition, ownership, and so on.

There are two methods to standardize hospital output: service-mix and case-mix. The service-mix approach uses information about the types of services offered by the hospital (e.g., obstetrics and gynecology, oncology) as a basis for standardizing hospital output. The existence of common services among providers does not imply that the mix and complexity of cases, as well as the quality of care, are similar among providers. Knowing whether or not certain services are offered by a particular provider is not sufficient to characterize its output, because there is a lack of information about the extent to which those services are actually used.

The case-mix approach attempts to standardize hospital output according to the mix of cases actually treated in hospitals. Both methods reflect demand and supply forces, since the services offered by hospitals generally respond to demand in the longer run. The case-mix approach, however, captures supply-demand interactions better because it is based on utilization information. Under the case-mix approach, there are several distinguished methods; they are: specialty mix, diagnostic related groupings, information theory, case severity, and other measures (10). Appendix 2 summarizes the approaches available to standardize hospital output.

2.3. Hospital cost function

Cost function is the minimum cost of producing a given output level, during a given time period, expressed as a function of input prices and output (11).

There are two very different methods of hospital cost analysis. The first method makes use of accounting information and reanalysis of hospital service records to examine hospital costs and performance. The second one makes use of statistical procedures to infer the relation of hospital costs to services provided. The accounting method can be applied usefully to a single hospital. Less detailed data are needed in the statistical method, but it requires observations of costs and service use for many (>= 30) hospitals. Statistical studies provide insights into cost issues-the relation between marginal and average cost, and the degree to which hospitals exhibit economies of scale and scope-that accounting studies do not reveal as readily (1, 12).

2.4. Ad Hoc Cost Function

Multivariate analysis and associated techniques are most used in deriving the ad hoc functional form cost models. This approach assumes, that the impact on unit costs of the various cost determinants, are both linear and separable additively. Lave, Lave and Silverman (13) used a linear regression to estimate the cost per patient, using 65 Western Pennsylvanian hospitals to analyze 32 parameters. Several case types were classified into two sets,

a) characteristic variables; and
b) diagnosis variables.

The characteristic variables were 15 institutional variables including hospital site, occupancy rate and teaching status as well as summary statistics of in-patient population with age distribution, extent of commonality in the diagnosis and surgery variables, based on the International Classification Disease Amended (ICDA) system. To address the problem of collinearity, parameters were reduced using the principle component analysis and were clustered using principal component technique.

Grannemann, Brown and Pauly (14) used a hybrid functional form which incorporates desirable features, both of some ad hoc functions and of commonly used forms for structural cost functions, in estimating a hospital cost function, based on data from 867 hospitals in the US. In contrast to the "pure" structural cost functions, which incorporate only output quantities and input prices, the hybrid form includes potentially relevant variables on an ad hoc basis, while allowing economies of scope and scale to be incorporated as testable hypotheses. While the large sample size in this study eased the trade-off between flexibility in functional form and parameter parsimony, the use of interactive terms between a range of output categories still result in a relatively high degree of output aggregation. In total, 63 regressors were included in the estimated equation. These hospital cost studies confirm the above argument that adoption of such a form involves a trade-off between flexibility of functional form and parameter parsimony.

2.5. The Behavioral Cost Function

Evans (15) argued that the true cost curves (based on either the profit maximization or cost minimization process) can't be derived for the hospital sector, as hospital management and/or medical staff committees influence rates of hospital utilization, through scheduling of laboratory and operating times, bed availability and regulatory constraints. Hospital managers endeavor to choose both inputs and outputs to reach an optimum position than maximum profit. Deviation from this optimum would be a function of random 'disturbance' factors, and could not be relied upon, to trace out a technological cost curve.

Evans (15) used the 1967 discharge data of acute care hospitals in Ontario, Canada, to relate measures of cost per day and per case to a variety of hospital characteristics including hospital size, levels of activity, and patient diagnostic and age-sex mix. The diagnoses were grouped into 40-categories (male/female in each five-year age span from 0 to 100). Sets of four vectors of proportions were derived for the diagnostic groups, age-sex characteristics and total days of care supplied.

The vectors of proportion were condensed, using the factor analytical technique, with the diagnostic variable vector reduced to 10 factors and each age-sex vector to 6. The reduced factors for the diagnostic proportions accounted for 70 per cent of those vectors based on days of care provided. Results showed the importance of the diagnostic and age-sex factors in explaining inter-hospital cost variation. Adjustment of these factors accounted for 85 per cent of inter-hospital variance in cost per case.

Given the importance of the effects on economic efficiency of different hospital objectives, Feldstein (16) undertook an examination of the behavior objectives of hospitals. He stipulates three groups important in the determination of hospital objectiveness. These groups include: a) the trustees; b) the administrators; and c) the medical staff. The behavior models assume that one group is dominant in the decision-making process. He concluded that in an era of extensive third-party reimbursement and cost-based payment of hospitals, the decision makers recognize that the output mix of the hospital industry is unlikely to be optimal.

2.6. Neoclassical Cost Function

In the neoclassical theory of the firm, cost function is defined to describe minimum cost of providing a given volume of output, as a function of the exogenous vector of input prices. The cost functions were developed from theoretically consistent properties and propositions about short-run and long-run cost structures.

An example of the use of a multiproduct translog cost function is provided in the case of US railroads by Brown, Caves and Christensen (17). Using two outputs (freight and passenger services) and three inputs (capital, labor and fuel), an unrestricted (except for linear homogeneity in factor prices), translog cost function together with four restricted versions were estimated. The four versions were based upon,

a) constant returns to scale or linear homogeneity in outputs;

b) input/output separability;

c) homogeneity plus separability; and

d) a separable form with Cobb-Douglas aggregator functions for inputs and outputs.

Two studies on hospital costs, which employed translog cost functions, are those by Conrad and Strauss (18) and Cowing and Holtmann (19). In the former, data on 114 North Carolina hospitals were used in a specification comprising three outputs (non-Medicare, Medicare, and child in-patient days) and four inputs (general services, nursing services, ancillary services, and capital). As in the railroad study, a number of restricted versions of the function were tested, under scenarios of: a) linear homogeneity in outputs; b) input/output separability; and c) homogeneity plus separability. Constant returns to scale could not be rejected, but the remaining two restrictions were statistically unacceptable. Nursing and ancillary services were found to be complementary to capital, while general services and capital were substitutes. Marginal cost of child in-patient days was substantially greater than the marginal cost of patient days in the other two output categories. The authors concluded that complementarity between capital and nursing and ancillary services might provide an explanation of rapidly increasing hospital cost, since the technology of treatment has become capital-intensive increasingly.

Cowing and Holtmann (19) develop and estimate a multi-product, short-run hospital cost function. Since the hospital is assumed to be a multi-product firm, different outputs including inpatient hospital care and emergency room visits rather than one single measure of output is used. Five outputs and six input price variables were included, along with the book value of buildings and equipment as a measure of capital. The number of admitting physicians and dummy variables were used to identify ownership type and teaching status.

The model is specified using a translog cost function and the data includes 138 short-term, general hospitals for observations made in the year 1975. The results are as follows: elasticities for output showed a positive relationship with cost, there are economies of scope, and finally, there are economies of scale with respect to cost. Important points from this study are that if specifying a total cost function for hospitals, the multi-product nature must be considered. Variables for output should reflect different outputs for different departments of the hospital. Cowing and Holtmann choose patient days for various inpatient departments and emergency room visits as measures of output. They stress input prices for labor, supplies, and capital should be included in the model, which many studies tend to ignore.

Finally, Cowing and Holtmann describe the need for a physician variable since doctors are an integral part of the care delivery. They argue that exclusion can lead to specification error and use the total number of admitting physicians per hospital for the physician variable.

Breyer (8) provides a list of hospital and patient-related characteristic used in hospital cost analysis,

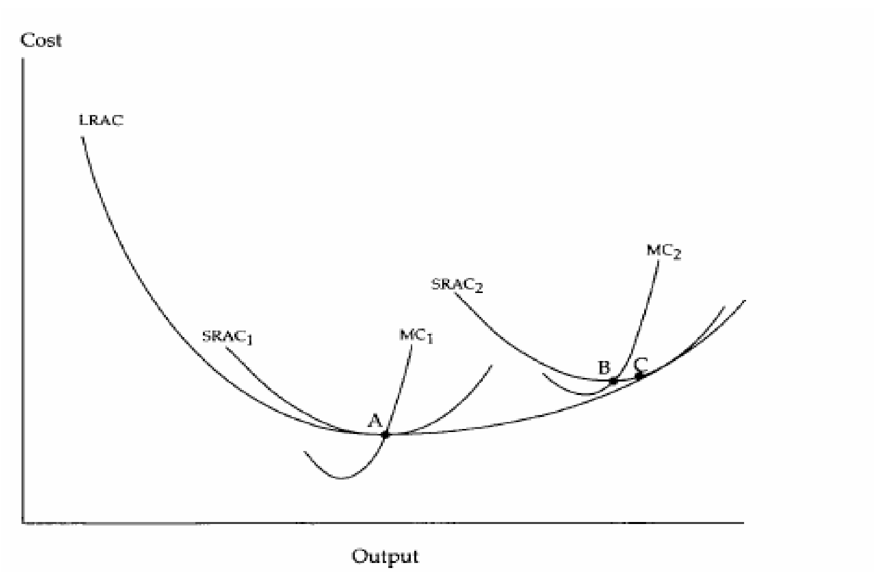
- Capacity (bed size);
- Global indicators of hospital activity such as case flow, average occupancy rate or average length of stay;
- Case-mix, measured by the proportion of patients in various diagnostic categories, defined by a detailed classification code;
- The wage level of hospital employees;
- Dummy variables for teaching status;
- Indicators of hospital facilities and services;
- Characteristics of the market for inpatient services with regional income level, physician density or hospital bed density.

2.7. Short-run and Long-run cost function

Authors of cost studies have also been more careful to distinguish between short- and long-run cost functions. This distinction is important for the identification of economies of scale, which is a long-run concept. In empirical applications, the distinction between long- and short-run cost functions is related to the specification of the time period and the inclusion of a scale or capital proxy as an independent variable. If the hospital cannot adjust the capital stock within the period of time defined by the data, as would commonly be the case if the cost and output data refer to a one-year accounting period, then a short-run variable cost function is appropriate. It is possible to examine the behavior of the variable cost function with changes in the capital stock (in this case the number of beds) and derive a long-run function. The importance of this is that it is then possible to derive an index of long-run economies of scale from an estimated short-run variable cost function.

For heuristic purposes (though it may not be descriptive of the actual shape of a given estimated function), figure 1 shows a general graphical description of the relation between long- and short-run cost curves, presented in average cost format, for a single output. With reference to the figure, one can distinguish between the short- and long-run behavior of cost with changes in output by differentiating between returns to scale (a long-run concept) and returns to the variable factor (a short-run concept).

Figure 1: Relation of Short- and Long – Run Average Cost Function



Looking first at different locations along the long-run average cost function (LRAC), the hospital with the short-run average cost (SRAC 1) curve is at an optimum plant size and can be characterized as having constant returns to scale when producing the long-run minimum cost output at A. To the left of A on the LRAC, average cost falls with increases in hospital size (increasing returns to scale). To the right of A, average cost increases with hospital size (decreasing returns to scale).

Looking at locations on a short-run average cost function, for example, SRAC 2, given the fixed scale, the hospital is at its most efficient level of output at B and is above this short-run optimum at, say, C. At C, the cost of an additional unit-the marginal cost (MC)- is above the average cost. At point B the hospital is at a point of constant returns to the variable factor. To the left of B, short-run average cost decreases with greater output, yielding increasing returns to the variable factor, and to the right of B, say at C, there are decreasing returns to the variable factor. Thus we distinguish between movements along the short-run cost curve by discussing returns to the variable factor and movements along the long-run cost curve by discussing returns to scale. This distinction is not always carefully made in the literature on hospital cost functions. Failure to make this distinction has led to errors in estimating economies of scale and that such failure is caused by applying long – run formulas to short – run empirical cost functions (1).

2.8. Treated Cases and Length of Stay

A unit of output measurement commonly adopted in studies of hospital costs is the patient day, with total output over a given period, then being taken as the total number of patient days provided over that time period. This is considered as an alternative to measure output, by using the number of cases treated.

Studies argued that the treated case was a priori, a more defensible unit of output measurement than the patient day. Indeed, the latter is more like an input measure relating to the time dimension of the production of a treated case. The number of patient days, which a hospital uses to produce a treated case, indicates the time period over which production of one unit of output takes place, for it does not measure the output itself.

The treatment conception of hospital output accords with the view of hospital output, as an intermediate product used as an input into the production function for health. If one consider that the final product of the medical care process is the provision of the highest attainable of health, given the state of the arts, it is clear that the output of hospitals is more precisely an intermediate input into this process.

Whatever position is adopted on these conceptual issues, empirical reality is the way hospital output forms the basis of most applied work on hospital cost analysis. Discussion showed stress consideration of the unit of measurement to be employed in empirical applications, based on patients treated or discharged.

Patients receiving treatment face degrees of uncertainty of the effect of that treatment on their health. If patients pay for treatment and gain nothing in terms of their health status then that amounts to financial loss. Financial loss may include loss of income, due to reduced earning ability arising from the prolongation of the illness. Under such a circumstance, insurance could be provided by a third party who pays for the treatment in the event of being unsuccessful. The hospital or the medical practitioner could also provide it, if they agreed to accept full payment, only if the treatment improves health. Under these circumstances, the risk of the financial loss following unsuccessful treatment is shifted to the supplier of the treatment. The supplier can now be thought of as producing not one but two outputs: a) the treatment itself; and b) insurance, against the financial loss that may arise because of the uncertain impact of that treatment on health status.

It should be noted that the treated-case has been argued to be a defensible unit of output, than patient-day for treatment provided in hospitals. The argument does not apply necessarily to other institutions, which may be providing a different type of output. In-patients in nursing homes do not generally receive treatment for a specific illness or illnesses, but are assisted or cared in matters of everyday living (cooking, bathing, and so on). For such institutions a strong case can be made, that a day of care is the unit of care, not a treatment. This can give rise to problems in measuring hospital output, if nursing home type patients are being cared in hospitals (along with the usual patients requiring acute care). They should, therefore, be recognized as receiving a conceptually distinct type of output. This distinction, however, is often drawn in theory than in practice, giving rise to empirical problems. In discussing the concept and measurement of hospital output, treatments may differ for different illnesses. Under these circumstances, a treated case may not be a homogeneous unit of output even within a hospital. This is another important dimension of the multi-product nature of the hospital, to be addressed (7).

2.9. Some excerpt of Studies of developing countries

Anderson (20) conducted a statistical study of hospital costs using a sample of 51 Kenyan hospitals with data from the years 1975-76. Using OLS, he estimated an average cost function where the dependent variable was average cost per patient day (ACPD) and the explanatory variables were the capacity (SCALE) (as measured alternatively by available and used beds); the occupancy rate (OCR); the average length of stay (ALS);

the number of outpatient visits per inpatient day (TOPPD); the number of satellite ambulatory facilities operating under the hospital (SAT); and the nature of the hospital (PHD) (provincial or non-provincial).

In Anderson's analysis, four alternative specifications of the model (using alternative dependent and independent variables) were estimated. According to his analysis the hospitals in the sample were operating with increasing returns to scale, as evidenced by negative (decreasing average cost) and statistically significant coefficients associated with the scale variables. He also found that higher occupancy levels resulted in lower average costs, concluding that greater demand should be accommodated within existing hospitals rather than through new ones. Outpatient activity was found to increase average cost, as expected. In contrast, length of stay did not come out statistically significant. Finally, provincial hospitals were found to have higher average costs than district and sub-district facilities.

Some limitations of the analysis, as pointed out by the author, included the inability to control for differences in quality of care, case mix, and input prices. Some or all of these shortcomings, however, have also been reported in the other studies described below.

Dor (21) estimated average cost functions for a sample of 19 Ministry of Health (MOH) and Social Security (IPSS) urban hospitals in Peru. A key explanatory variable was patient flow (F), which is equal to the ratio between the number of hospital admissions (ADMISS) and the number of beds (BEDS). Other dependent variables included case-mix variables (share of admissions that were deliveries; share of admissions that were surgery), an affiliation dummy (IPSS or MOH), and the volume of outpatient visits.

Based on his average cost equation, Dor calculated an analytical expression for the optimal patient flow, i.e., the flow at which hospital average cost is minimum. Using OLS and weighted least squares (WLS), he estimated separate average cost functions for all cost categories combined as well as for each of his three cost categories separately (the categories were labor, goods, and services). He found that hospital average cost decreased with service intensity (although at a decreasing rate). This means that average cost of hospitalizations went down if the number of hospitalizations increased, or the number of beds decreased, or both. He computed an optimal flow value of 4.2 (admissions per bed per month) that was above the sample mean but below the actual flow of several hospitals in the sample. He thus concluded that the average cost curve was U shaped. He also found that the aggregate number of hospital beds of both institutions should be reduced to move toward a minimum average cost point. Finally, he observed that, other things being equal, IPSS hospitals exhibited higher average costs than MOH institutions.

Bitran and Dunlop (22) studied the determinants of hospital costs using a sample of 15 government hospitals in Ethiopia, with one to three annual observations for each, for a total of 38 observations. The study involved estimating a total cost function using OLS with a functional form similar to that introduced by Grannemann et al.

The authors found that the hospitals in the sample were operating under constant returns to scale for patient days, laboratory exams, and deliveries. Economies of scope were found between first outpatient visits and inpatient days, signaling an economic advantage to the joint production of inpatient and outpatient care. The number of hospital beds affected total hospital costs in a statistically significant and economically important way. Input price proxy variables performed poorly in the regressions.

A limitation of this type of analysis is that cost minimization cannot be assumed a priori. The estimated coefficients may be biased estimators of the minimum cost coefficients. As a consequence, the associated measures about technology (e.g., economies of scale and scope), derived from the estimated cost function, may also be biased. Another limitation of the work of these authors is that they used as an independent variable hospital expenditures, as reported by the Ethiopian government. This figure probably underestimated the actual resources used in production, because it did not include possible donor gifts and the depreciation of capital. An additional possible limitation is that reported expenditures may depart from the actual social cost of the resources used in hospital operations. Finally, the sample of hospitals used by Bitran and Dunlop was bi-modal with respect to hospital size. Estimation of cost from the pooled sample of small and large hospitals could be a shortcoming if the true cost relations differed between the different size facilities. Unfortunately, the small number of observations precluded separate estimation of cost functions for small and large hospitals.

Wouters (23) studied the costs and efficiency of a sample of 42 private and public health facilities in Ogun State, Nigeria. The sample included a heterogeneous range of facilities, including comprehensive health centers, primary health care clinics, maternities, health clinics, and dispensaries. Wouters analyzed costs and efficiency, estimating a production and a cost function, and deriving associated measures of efficiency.

The cost function estimated by Wouters included as independent variables the volume of outpatient visits and inpatient admissions, the proportion of patients obtaining drugs, the wages of both kinds of health workers, the availability and number of beds, and an efficiency index. She found that the efficiency variable was insignificant and thus concluded that departures from cost minimization had little effect on expenditures. She also found that marginal costs were less than average costs and thus concluded that the facilities in her sample exhibited increasing returns to scale for both admissions and outpatient visits. With regard to economies of scope, she concluded that there were no apparent advantages to the joint production of inpatient and outpatient care.

2.10. Summary and Conclusion:

This section is dedicated to summarizing some of the important considerations made in the literature and what influences it has on this study. The hospital cost function literature provides us with the framework necessary to develop a model for hospital cost. In this study specification has been developed from neo-classical production theory using flexible cost functions such as the translog. These models are able to approximate any arbitrary cost function at the point of estimation. Using the estimated cost function, it is able to explore issues of economies of scale and scope among the output types.

The translog model has been widely used in prior research on the cost structure of U.S. hospitals, U.S. nursing homes and U.S. health maintenance organizations. The translog model has also been used to model hospitals costs in New Zealand, Greece and in developing countries (24).

The translog model can be used to explore some of the important aspects of hospital costs. As it is shown in the study, it is possible to determine the extent of economies of scale and scope for the average hospital.

Even if it is not possible to treat in this study due to limited data on inputs, another advantage of the translog formulation is the ability to measure the substitutability of various inputs for the average hospital.

The studies reviewed provide the essential elements that need to be included in the cost function. For example, hospitals are treated as a multi-product firm, thus, this study will include variables reflecting different services provided by hospitals. Also, every researcher has stressed the need to include factor input prices, such as wages, in the model. Failure to do so could lead to specification errors. Furthermore, a variable reflecting physician input in the production of hospital care is necessary. Consequently, a physician variable measured by the total number of admitting physicians per hospital is included.

Studies found that hospitals included in their sample were operating under either increasing or constant returns to scale for different variables. Regarding economies of scope there was some or no clear evidence of economies of scope.

Many public health experts believe that some of hospital resources would be better spent on preventive and primary care. Even within the hospitals' share, questions are raised about the efficiency of their scale and scope. The question about scale is whether larger hospitals are more or less efficient than smaller ones. On the one hand, hospitals require large investments in capital such as buildings, equipment and specialized staff, which may make it more efficient to have one large hospital rather than two small ones. On the other hand, hospitals are complex organizations to manage, and at some point a smaller hospital may run more smoothly than a larger one.

The question about scope is whether or not it is efficient to combine outpatient and inpatient care at the same facility. Physicians often need to see patients on both an inpatient and an outpatient basis; an outpatient who receives diagnostic exams may later be admitted or an inpatient that is discharged may need follow-up visits. In some cases, it may be more efficient for physicians to provide both types of care from a single office at the hospital. In other cases, it may be more efficient to reduce the daily flow of a large volume of outpatients at the hospital by having separate facilities.

These questions may be answered with estimates of a hospital cost function that shows the relationship between cost and output. Although researchers have estimated cost functions for hospitals in developing countries, the dearth of hospital cost studies in Ethiopia, where private hospitals are flourishing in the cities, initiated this study. The improvement of knowledge about the nature and effects of determinants of hospital costs have great impact on the process of health sector reform. By examining data for a number of hospitals this study will try to discover some of the characteristics of cost functions. It will also be useful for hospital managers and policy makers to know how hospital costs are influenced by output and other variables.

3. OBJECTIVES

3.1. General Objective:

- To identify and estimate the nature and effects of determinants of costs for a sample of government and private hospitals in Addis Ababa.

3.2. Specific objectives:

- To identify and describe determinants of costs of public and private hospitals in Addis Ababa.
- To explore the possible functional forms that explains the behavior of public and private hospitals in and around Addis Ababa.

4. EMPIRICAL METHODS

4.1. Model

This study draws its theoretical framework from an earlier hospital cost analysis by Bitran and Dunlop(22) in which hospital cost was modeled from a set of papers by Cowing and Holtmann (19), Conrad and Strauss (18), and Grannemann et al. (14), in which a translog-like cost specification is employed.

The econometric analysis employed in this study is similar to that of Bitran and Dunlop (22) since it enables an explicit determination of the marginal expenditure of care, given the structure of output, and other factors, such as input prices, that might affect the structure of expenditures and assumes that total hospital cost to be an exponential function of: a) input prices (P variables); b) output types and volume (Y and Z variables); and c) other factors assumed to be determinants of fixed costs (X variables). The total cost function may be defined as:

$$C = f\ (X, Y, P, Z),$$

where each variable is defined as follows. C is total annual cost, X represents the total number of beds in the facility and it is as a proxy measure for capital stock, Y is a function of various hospital products and outputs, and P is the input price. In the absence of input prices, one alternative variable was used a proxy for input price: P = (number of physicians)/ (total personnel). P captures possible differences in the average price of labor (those facilities with a higher percentage of physicians to total labor should have higher average wages).

4.2. Empirical Specification

There are four types of independent variables in the cost function: a) "X" variables, which are a vector of factors that affect the level but not the shape of the expenditure function with respect to the outputs; b) "Y" variables which are a vector of primary outputs such as the number of out-patient visits, in-patient admissions, and in-patient days; c) "P"' or input price variables; and d) *"Z"* variables which include a vector of other outputs produced in the hospital such as surgical procedures, x-ray tests, laboratory tests, and normal deliveries.

The total cost function employed in the analysis is an exponential and multiplicative function. Such a functional form is characteristic of a translog (transcendental logarithmic) specification. This functional form of the cost function is enables the cost-minimizing input mix to remains constant as the output level changes. This characteristic also means that as input prices change, cost estimates are affected only by a scale factor, but the relationship between marginal and average incremental cost or measures of economies of scale are not affected. Third, the approach explicitly allows for the use of separate measures of as many important hospital outputs as may exist in any given situation, including a disaggregation of output according to case type defined by disease and/or other characteristics. For example, in the context of hospitals in Addis Ababa, the hospital is an important producer of ambulatory as well as in-patient care. Thus, in this instance, both in- and out-patient measures of service are included as well as measures of lab and x-ray tests and surgical procedures. Thus, the cost function is as follows:

(1) $$C = e^{(m_0 + m_1 \bullet BEDS)} \bullet \underset{i}{p_i^{a_i}} \bullet e^{f(y)}$$

where C is total hospital cost, e is the base of the natural exponential function, m_0, m_1, and a_i are coefficients to be estimated, BEDS is the total number of beds in the hospital and has been included as a proxy measure for capital stock (i.e., an X variable), Pi is the price of the i^{th} input, and f(Y) is a function linear in output levels. Using the properties of multiplicative and exponential functions, the expenditure function can be linearized by taking the natural logarithm on both sides of expression (1):

(2) $\ln C = m_0 + m_l \bullet BEDS + a_i \ln P_i + f(Y)$

where

(3) $a_i \ln P_i = a_1 \bullet \ln PHY/PER$, and

(4) $f(Y) = b_{11} \bullet IP + b_{l2} \bullet OP + b_{13} \bullet DELIV + b_{14} \bullet XRAY + b_{15} \bullet SURG + b_{16} \bullet LAB$
$+ c_{11} \bullet IP^2 + c_{12} \bullet OP^2 + d_{11} \bullet IP{*}OP$.

In expression (3) PHY/PFR which is used as a proxy for input price, represents the proportion of physicians out of the total personnel in a hospital, and is intended to capture the relative average cost of labor in different hospitals.

In expression (4), IP and OP represent the volumes of in- and out-patient activity, respectively (i.e., Y vector variables). The 'Z" variables DELIV, XRAY, SURG, and LAB represent the number of deliveries, x-rays, surgical procedures, and laboratory exams performed at the hospital. The terms IP^2 and OP^2 represent the square of the variables IP and OP. The variable, IP*OP, is an interaction term which corresponds to the product of the variables IP and OP.

The above specification is linear in both the variables and the coefficients and therefore can be estimated using OLS.

Given the specification of the f(Y) function, the marginal expenditure functions become:

(5) $MCIP = C \bullet (b_{11} + 2 \bullet C_{11} \bullet IP + d_{11} \bullet OP)$, and

(6) $MCOP = C \bullet (b_{12} + 2 \bullet C_{12} \bullet OP + d_{11} \bullet IP)$.

The cost specification also enables one to compute the average incremental cost (AIC). AIC tells by how much average total cost will increase if output Yi is produced versus not produced at all. AIC is specified for a given level of output for all variables. More formally, AIC is defined in the following way:

(7) **AIC** $Yi = \{C(Y_1,Y_2,...,Y_i,...,Y_n) - C(Y_1,Y_2,...,0,...,Y_n)\}/Yi$

A final useful measure that has been computed is an indicator of product-specific economies of scale (EOS) i.e. larger quantities of the firm's output are produced at a lower average cost than are smaller quantities of output. In the multiple output case, the product specific EOS indicator can be computed as the ratio between the AIC and MC for any given output. Where economies of scale exist, the ratio between AIC and MC is greater than one. Where diseconomies of scale exist the ratio is less than one.

4.3. Data

4.3.1. Study Design:-

This is a cross – sectional analysis of hospital data that were collected during the period of Jan. 2007 – Feb 2007.

4.3.2. Study Area:-

The data for the analysis were collected from 30 hospitals in Addis Ababa, the capital city of Ethiopia. The city is located between 9 degrees latitude and 38 degrees longitude at an altitude of 2200-2800 meters above sea level. It has a population of 2.1 million. According to projection of the 1994 census, 46% were Amhara, 18.2% Oromo, 13.5% Gurage and 7.6% Tigre by ethnicity. Most of the private hospitals are located in the city (25).

4.3.3. Source population: -

The source populations for the study were hospitals that operate inside Addis Ababa. These include both government and non-government hospitals.

4.3.4. Sample size and sampling procedure: -

Due to financial limit and logistic constraints, the 30 hospitals in Addis Ababa were purposively rather than randomly selected. At the time, there were a total of 33 hospitals in the city. All the facilities with complete information on the variables defined in Table 1 for the financial years 2003-2005 were considered. This gave a sample of 30 hospitals comprising 15 general hospitals, 13 specialized hospitals, and 2 specialized referral hospitals. For each of these facilities, annual data for one to four fiscal years were obtained. This generated a total of 41observations for the study.

The main aim of the selection process was to choose hospitals which would reflect the range of types of public and private hospital in Ethiopia.

Interviews with key informants and document review were conducted to extract data on the types of hospital, staffing patterns, outpatient and inpatient volumes, capital stocks, materials, drug supplies, wages of staffs and total expenditure of hospitals.

4.3.5. DATA COLLECTION METHODS

Data for the financial years 2003 – 2005, wherever possible, were collected through trained individuals who visited all the hospital facilities, interviewed key informants and reviewed relevant records and reports. Checklists were used for interviewing the key informants as well as for extracting data from the hospital records.

4.3.6. DATA QUALITY ASSURANCE

All the data collected were checked for completeness, clarity and consistency by the principal investigator.

4.3.7. DATA ENTRY and ANALYSIS

Reviewed documents were arranged and summarized. Translog-like cost function similar to Bitran and Dunlop (22) was used to specify and estimate cost function. OLS (ordinary least square) regression equations were run to estimate the parameters on determinants of hospital cost using SPSS 11 software computer program.

4.3.8. ETHICAL CONSIDERATIONS

Consent of the study subjects was obtained after explaining the purpose of the study. The research does not cost additional expenses on the subjects. There are no potential risks that may cause any harm in any form. Letter of cooperation was given to the respective organizations. All information communicated with individual subjects or organizations is to be kept confidential and privacy is to be maintained. Ethical clearance was obtained from the Faculty of Medicine of Addis Ababa University.

4.4. VARIABLE DEFINITION

4.4.1. Dependent Variable

In this analysis the dependent variable is the total annual expenditures by hospitals in the provision of health care services. This variable specification does not include any provision for capital replenishment. The above-defined variable specification does not include expenditure of in-kind gifts which many hospitals have received from various international organizations.

4.4.2. Independent Variables

The independent variables included in the analysis and the expected hypothetical relationships with dependent variables are presented in Table 1.

i. "X" Variables

This set of variables includes indicators of the capital stock of the hospital which is: the number of hospital beds. The expected hypothetical relationships between total hospital cost and "X" vector variables can be summarized as follows. It is expected that hospital cost rises with the capital stock, as measured by the number of beds.

ii. "Y" Variables

The "Y" vector variables comprise the primary hospital output variables. These variables include measures of in- and out-patient activity, such as: a) the number of hospital admissions; b) the number of in-patient days; c) the total number of out-patient visits; d) the number of first out-patient visits; and e) the number of repeat out-patient visits. A first visit is recorded at the time an individual comes to the facility for a new illness episode, whereas a repeat visit is recorded if the visit is for an existing episode. The sum of first plus repeat visits is equal to the total number of out-patient visits. The hypothesized relationship between these independent variables and total hospital cost shows that as the total amount of patient activity increases, so does total cost.

iii. "Z" Variables

"Z" vector variables contain other hospital outputs such as the number of normal deliveries, laboratory tests, x-ray tests, and surgical procedures. These output indicators further define the complexity of the ambulatory and in-patient care provided. They also define the skill level of the staff employed at each facility and, thus, the cost of service. It is hypothesized that all of these outputs positively contribute to the total cost.

iv. "P"' Variables

"P" vector variables comprise a set of input price indicators which are included to control for possible differences in costs among facilities due to input price differences. Often one of the important input price differences across facilities is due to wage differences between various labor markets. Although wage information for each hospital was not available from our data set, in the case of Ethiopia there is little wage variation among facilities within personnel categories. This is because wage scales are nationally defined by the civil service system. However average personnel compensation may differ across facilities due to differences in personnel mix as well as differences in experience levels of the personnel employed in each facility. Further, it is expected that there is a tendency for a larger share of skilled health workers, particularly physicians, to be in the facilities which produce the more complex set of services, particularly those embodied in the "Z" set of output indicators. Thus, it is hypothesized that the ratio of physicians to total personnel employed in any facility is positively related to total cost.

Table 1: List of variables, definition, and expected sign

No.	Variables	Definition	Expected sign
		I. Dependent variable	
1	C	Total cost	
		II. Independent variables	
A) Capital measures			
2.	BEDS	Number of hospital beds	Positive
B) Primary output measures			
3	IPDAYS	Number of inpatient days	Positive
4	NIP	Number of inpatients	Positive
5	NFOP	Number of first outpatient visits	Positive
6	NOP	Total number of outpatient visits (first and repeat)	Positive
7	NROP	Number of repeat outpatient visits	Positive
C) "Other" output measures			
8	DELIV	Number of normal deliveries	Positive
9	LAB	Number of lab tests performed	Positive
10	XRAY	Number of x-ray tests performed	Positive
11	SURG	Number of surgical procedures performed	Positive
D) Input prices measure			
12	PHY/PER	Number of physician per total personnel	Positive

5. RESULTS

5.1. Descriptive Statistics

The descriptive statistics of the variables estimated in the model is presented in Table 2.

Table 2: Summary Statistics of the Variables

	Total Sample		**Public**		**Private**	
Variable	**Mean**	**S. Deviation**	**Mean**	**S. Deviation**	**Mean**	**S. Deviation**
Total expenditure(C) (in millions)	5.68	4.56	9.12	4.44	4.42	3.98
BEDS	86	101	220	113	37	16
NIP	2,709	4,768	7397	7202	991	1443
IPDAYS	7	1.8	8	1.7	7	1.7
NFOP	23,297	32,587	60070	43964	9814	9862
NROP	2,644	5,106	5842	8788	1472	2008
NOP	25,942	33,853	65912	43395	11286	10155
DELIV	470	1,064	1182	1881	208	282
LAB	24,504	28,267	37372	39372	19786	21949
XRAY	3,606	5,402	7684	8943	2110	2010
SURG	880	1,470	2361	2227	338	364
PHY/PER	0.16	0.08	0.13	0.11	0.17	0.07

The data in Table 2 provide various points:

(1) The hospitals involved in the study include private and public hospitals with different capacities including general, general specialized and specialized hospitals. The average expenditure is 9.21 and 4.42 million birr per annum to run individual public and private

hospitals respectively; but being specific, the expenditure is half million and 18 million respectively to run the general hospital and general specialized hospitals.

(2) Public hospitals in Addis Ababa handle, on average, 65,912 outpatients and 7,397 inpatients per annum. This means that they treat an average of 181 outpatients and 20 inpatients per day. Private hospitals handle, on average, 11,286 outpatients and 991 inpatients per annum. This means that they treat an average of 31 outpatients and 3 inpatients per annum. The wide differences in work-load could be a reflection of the capacities of the facilities in diagnostic, therapeutic and medical care services a facility offers.

(3) The average number of operations and deliveries at the private hospitals are 338 and 208 respectively, for public hospitals the average number of operation and deliveries are 2361 and 1182 respectively. These variations suggest that differing abilities and specialization of hospitals and, perhaps, certain constraints exist among the hospitals.

(4) The average number of physician per total personnel at private and public hospitals are 17% and 13% respectively. Computing it with the number of outpatients and inpatients, physicians working in public hospitals are more overloaded and less paid compared to private hospitals.

In general, the descriptive statistics exhibit wide deviations from their mean values, with inpatient days demonstrating the highest index. These deviations probably reflect the wide disparities in the capacities and specialties of the different hospitals.

5.2. Regression Results

Table 3 presents the results of the determinants of total hospital cost. The results reveal that both the intercept and the number of BEDS variable, which can be interpreted as measures of fixed cost, were positive and statistically significant.

Table 3: Regression results of the determinants of total hospital cost

Variable Name		Coefficients	t	Sig.
Intercept,	m0	14.371	65.720	0.000
BEDS	m1	6.668E-03	2.492	0.018
NIP	b11	1.489E-04	1.222	0.231
NFOP	b12	-6.298E-05	-2.775	0.009
DELIV	b13	-1.751E-04	-1.171	0.251
XRAY	b14	3.539E-05	0.741	0.464
LAB	b16	2.204E-05	3.497	0.001
IP2	c11	5.490E-08	1.892	0.068
OP2	c12	1.541E-09	2.680	0.012
IPXOP	d11	-1.726E-08	-2.285	0.029

Adjusted R-square: 0.458, F = 4.75

The results presented in Table 3 include NFOP as the indicator of outpatient care with the estimated coefficient being negative but statistically significant. Alternative specifications which included both NFOP and NROP did not provide better statistical results relative to the specification that used only NFOP, as well as ones included NOP did not provide better statistical results relative to the specification that used only NFOP.

The variable IPDAYS sign is consistently negative and not significant. Instead NIP is included in the regression as the indicator of in-patient care with the estimated coefficient being positive but not statistically significant.

Four other output variables were included in the empirical analysis: DELIV, LAB, XRAY, and SURG. It was found that only two of the four (LAB and XRAY) consistently had the expected positive sign and one (LAB) was statistically significant.

5.3. Marginal and Average Incremental Cost

The marginal and average incremental cost for the principal outputs whose estimated parameters were statistically significant (i.e. NFOP and LAB) were calculated using equations similar to (5), (6), and (7), as specified earlier. The calculations were done using the mean values for all variables and are presented in Table 4 along with the calculated product specific economies of scale index (EOS).

Table 4: Estimates of Marginal and Average Incremental Cost and product specific Economic of Scale

		NFOP	LAB
1	Marginal Cost (MC)	-162.42	94.35
2	Average Incremental Cost (AIC)	-613.23	72.90
3	Product Specific Economies of Scale (EOS)	3.78	0.77

As it is shown in Table 4, the measure of economies of scale for LAB was 0.77 indicating the representative hospital was operating within the diseconomies of scale of range of output for the laboratory service. The measure was 3.78 for NFOP indicating economies of scale.

This value suggests that hospital output NFOP could increase by 3.77 % when all inputs are increased by 1%. From another perspective, a 3.77% increase in NFOP output is associated with less than proportionate increase in cost.

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6. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

6.1. DISCUSSION

6.1.1. Determinants of hospital cost

The results of the determinants of total hospital cost reveal that both the intercept and the number of BEDS variable, which can be interpreted as measures of fixed cost, were positive and statistically significant.

An estimate of the fixed costs of an average-size hospital can be obtained by evaluating the estimated cost function at a zero output level and by using average values for the number of beds. When outputs are set to zero, the total expenditure function defined in (1) becomes:

$$C = e^{(m0 + m1 \bullet BEDS)}.$$

When this equation is evaluated at the average value of BEDS=86, and using the estimates for m0 and m1 from Table 3 we obtain a fixed cost estimate of 3,093,000 Birr. This fixed cost represents approximately 54 percent of the total annual expenditure for the average hospital of nearly 5,685,000 Birr and it is higher than the study done by Bitran and Dunlop (21) which was 34.7%. The main expenditure item which comprises the fixed component is wages and salaries. The difference could be the involvement; rather the majority (73%) in this study is private hospitals. Private hospitals expenditure on wages and salaries are higher than the government. Other fixed costs like purchase of equipment could be the reason for the difference because most of the equipments in government run hospitals are not purchased but donated.

The positive sign of BEDS obtained suggests the existence of excess capacity in hospitals and that the 41 hospital data sets in the sample are too many for the output being produced. In other words, the cases of outpatients, inpatients, operations and other outputs recorded by the 30 hospitals studied could have been produced by fewer hospitals if resources were utilized more efficiently.

Outpatient care output can be measured by several alternative indicators, including the total number of out-patient visits (NOP), the number of first out-patient visits (NFOP), and the number of repeat visits (NROP). Each of these indicators of outpatient care output was empirically investigated singly and in various combinations. The NFOP included as the indicator of outpatient care with the estimated coefficient being negative but statistically significant. Alternative specifications which included both NFOP and NROP did not provide better statistical results relative to the specification that used only NFOP, as well as ones included NOP did not provide better statistical results relative to the specification that used only NFOP. Since NOP includes both resource intensive and relatively non intensive visits, it is understandable that it did not perform as well as a more disaggregative indicator such as NFOP. Also, since repeat visits (NROP) is less resource intensive it was expected that their impact on cost would not be as great. Thus, from an empirical perspective NFOP was the preferred out-patient indicator (21).

From an in-patient care perspective, two measures of output were investigated. These were the number of in-patients (NIP), and the number of in-patient days (IPDAYS). Contrary to the finding of Bitran and Dunlop (22) the variable IPDAYS sign is consistently negative and not significant. Instead NIP is included in the regression as the indicator of in-patient care with the estimated coefficient being positive but not statistically significant.

Four other output variables were included in the empirical analysis: DELIV, LAB, XRAY, and SURG. It was found that only two of the four (LAB and XRAY) consistently had the expected positive sign and one (L AB) was statistically significant.

It was unclear from the analysis why the variable DELIV and SURG performed contrary to expectations with a negative sign, and often statistically insignificant. This result can be attributed to the fact that the fee for operation is expensive in private hospital and also surgeons in governmental hospitals are scarce. After Referral system implemented in Addis Ababa most deliveries could be handled in health centers and a few complicated case only referred to hospitals.

The variable PHY/PER was statistically insignificant and its sign was negative therefore it was dropped from the results presented in Table 3 similar to the study done by Bitran and Dunlop (22). Further, the exclusion of PHY/PER variable resulted in a better statistical fit as measured by R-bar squared.

Given that hospitals in the study were either public or private hospitals, it was tried to divide into two sub-groups public and private hospitals. The limited number of observation in public hospitals precludes for running OLS regressions. OLS regression was run on private hospital samples and as it is shown in the appendix 3 adjusted R-Square is doing better than the total samples. Number of beds and number of inpatients have positive sign and statistically positive. Number of Laboratory tests performed, number of X-ray tests done and surgical procedures done had positive impact on the total costs of private hospitals.

6.1.2. Economies of scale and scope

The measure of economies of scale for LAB was 0.77 indicating the representative hospital was operating within the diseconomies of scale of range of output for the laboratory service. The measure was 3.78 for NFOP indicating economies of scale.

This value suggests that hospital output NFOP could increase by 3.78 % when all inputs are increased by 1%. From another perspective, a 3.78% increase in NFOP output is associated with less than proportionate increase in cost.

A negative and statistically significant coefficient associated with the output interaction term indicated the existence of economies of scope between the number of in-patent and out-patient new visits similar to that of Bitran and Dunlop (22). Regarding the private hospitals analysis alone there is a positive and statistically insignificant coefficient associated with the output interaction term indicated there is no evidence of economies of scope.

The general conclusion of Cowing, Holtmann, and Powers (11) in their survey of industrial country studies is that "economies of scale may exist for small hospitals but that moderate and large size hospitals can generally be characterized by constant returns to scale."

The estimates of marginal and average increamental cost and product specific economies of scale in this study and the five studies of developing countries surveyed by Barnum and Kutzin (1) Ethiopia, Kenya, Nigeria, China and Colombia (see annex 4) are consistent with the literature concerning industrial countries. With regard to long-run economies of scale, Anderson in his study of Kenyan hospitals, found economies of scale. However, in the analyses for Colombia and China it is found that either diseconomies of scale or constant returns to scale at the sample averages. With regard to short-run returns to the variable factor, with the exception of this study, the four studies found either decreasing or constant returns at the sample averages.

In three of the four studies of Barnum and Kutzin (1) and in which the functional form allowed an index to be computed, there was no clear evidence of economies of scope. The Colombian and Chinese data yielded an index value of 0.2 or less between outpatient and inpatient services. The Ethiopian data suggested that some economies of scope may exist between bed-days and outpatient visits and it is consistent with the finding of this study between inpatient and outpatient visits.

These results are also consistent with the literature on industrial countries, although in medium to large hospitals some diseconomies of scope have been identified. In their analysis of U.S. hospitals, Grannemann, Brown, and Pauly (14) found that there were some diseconomies of scope between outpatient visits and inpatient care - hospitals with larger numbers of inpatients also had a higher unit cost of outpatient visits. Their explanation for this phenomenon may be useful in understanding the interaction of inpatient and outpatient costs in large hospitals in developing countries. They state that the difficulty of coordinating a greater range of services may contribute to higher costs. Also, larger hospitals may have outpatient visits of greater complexity that give rise to longer or more costly inpatient stays. It may also be that larger hospitals have more trained personnel and available techniques that are applied to outpatient services independently of case complexity. In other words, the "quality" of outpatient care in larger hospitals in terms of resources used per patient may be better.

6.2. CONCLUSION

This study set out to identify and estimate the effects of determinants of costs for a sample of government and private hospitals in Addis Ababa. On the whole the results of this study suggest that most if not all principal hospital outputs had a positive effect on total cost and it also suggest that for the average hospital, there are economies of scale in the production of volume of out-patents measured by the number of first out-patient visits to the hospitals. This result is consistent with the findings throughout the literature but contrary to one compared in this study i.e. Bitran and Dunlop (22).

The results also indicated that the volume of in-patient activity, as measured by the number of in-patient, had a positive impact on total costs. A negative and statistically significant coefficient associated with the output-interaction term indicated the existence of economies of scope between the number of in-patients and first outpatient visits. The number of total beds in a hospital appeared to have a positive and significant effect on total hospital cost. The input price proxy variable did not indicate a statistically significant impact on total cost.

The cost function used by Bitran and Dunlop (22) allows determination of the marginal expenditure for care, given the structure of output and other factors such as input prices that might affect the structure of expenditures. Thus it provides a theoretically more appropriate framework for analysis in developing countries in general and in Ethiopia in particular where there are lack of adequate information on both output levels and input prices.

The results of studies performed on hospital costs in Ethiopia are too limited to provide definitive guidance for policy. The potential usefulness of such studies is established, however, by the illumination it could shed on the relation between marginal and average cost and between economies of scale and economies of scope. The setting of hospital prices can be done more efficiently with knowledge of marginal costs, and economies of scale and scope should be included in hospital design and organization. As experience grows with statistical analysis of hospitals in low-resource environments and with larger hospital databases and improved specifications, the studies will be of increased usefulness for setting prices and planning hospitals.

6.3. RECOMMENDATIONS

The estimated results imply that it is efficient to combine outpatient and inpatient care at the same facility. Physicians often need to see patients on both an inpatient and an outpatient basis; an outpatient who receives diagnostic exams may later be admitted or an inpatient that is discharged may need follow-up visits.

The estimated results imply that hospitals require large investments in capital such as buildings, equipment and specialized staff, which may make it more efficient to have one large hospital rather than two small ones.

Additional empirical investigation is warranted. Clearly, when additional information becomes available, it will be important to disaggregate the sample by hospital size and type to separately estimate the equations of cost determinants. Both the output and input structure may be different enough between private and governmental and between small and large facilities to warrant a separate analysis. Improved measures of input prices are also required.

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APPENDIX 1

KEY INFORMANT INTERVIEW AND HOSPITAL CHECK LIST QUESTIONNAIRE

CONSENT FORM

Addis Ababa University, Medical Faculty, Department o f Community Health

Survey Questionnaire on Determinants of hospital cost in Addis Ababa

001. Questionnaire Identification number __/__/__ Hospital Number ____________

002. City______________ 003. Region______________004. Kebele ____________

Introduction:

My name is ___________________________. I am working for a thesis research project conducted in the Addis Ababa University medical faculty department of community health. We are interviewing people working in the hospital and other responsible stakeholders on hospital costs and its activities.

Confidentiality and consent:

"I am going to ask you some questions that some people find it difficult to answer. Your name will not be written on this form, and will never be used in connection with any of the information you tell me. You do not have to answer any questions that you do not want to answer, and you may end this interview at any time you want to. However, your honest answers to these questions will help us better understand what determines hospital costs. We would greatly appreciate your help in responding to this survey. The survey will take about 40 minutes to ask the questions."

Would you be willing to participate? (Indicate by ticking the appropriate response)

Yes _______________No ________________

Signature of interviewer certifying verbal informed consent ___________

Interviewer visit

	Visit 1	Visit 2	Visit 3
Date			
Interviewer			
Result			

Result codes: 1. Completed 2. Respondent not available 3. Refused 4. Partially completed 5. Others

005. Interviewer: Code __/__/ Name ____

006. Date of interview ___/___/___ Time _________________

007. Checked by Supervisor: Signature ________day _______month ______ year____

1. GENERAL INFORMATION

100. FACILITY IDENTIFICATION

Name of hospital ____

Code of facility: region _________ sub city/woreda_____________ kebele _______________

101. TYPE:

Specialized referral hospital 01

Specialized hospital 02

General hospital 03

Regional hospital 04

Zonal hospital 05

102. Managing authority

MOH 01

OGO 02

NGO 03

PRIVATE (FOR-PROFIT) 04

103. Date of establishment ____________________

2. STAFFING

No	Questions	Coding categories	Go to

200	**Now I have some questions about staffing for this facility.** **Please tell me how many full-time staff does have in the following categories**		
No	Qualification	Actual number	
01	General practitioner		
02	Obstetrician/Gynecologist		
03	Internist		
04	Surgeon		
05	Pediatrician		
06	Radiologist		
07	Midwife		
08	Nurse		
09	Professional nurse (BSC)		
10	Health officer		
11	Pharmacist		
12	Pharmacy technician		
13	Laboratory technologist (BSC)		
14	Laboratory technician		
15	Health assistant		
16	Ophthalmologist		
17	ENT specialist		
18	Anesthesiologist		
19	Environmental health worker		
20	Administrative staffs		
21	Sum the number of staff reported		
201	In addition to the above mentioned staff, does this facility have any visiting (part time) people who are not officially assigned in the following categories	YES …. ……………. 1 NO ……..…………2	➔ 203
202	**Please tell me the qualification the people who are part time workers to the facility**	**Actual number**	

01	General practitioner		
02	Obstetrician/Gynecologist		
03	Internist		
04	Surgeon		
05	Pediatrician		
06	Radiologist		
07	Midwife		
08	Nurse		
09	Professional nurse (BSC)		
10	Health officer		
11	Pharmacist		
12	Pharmacy technician		
13	Laboratory technologist (BSC)		
14	Laboratory technician		
15	Health assistant		
16	Ophthalmologist		
17	ENT specialist		
18	Anesthesiologist		
19	Environmental health worker		
20	Administrative staffs		
21	Sum the number of part-time staff		
203	Does the hospital provide the nurse training?	YES ………………. 1 NO……….…………2	

3. HOSPITAL MORBIDITY REPORT DATA:

	Now I would like to ask you a few questions about reports on clients who are seen in this facility. Ask to see the reports for the year 2002-2005					
	Types of outpatient services	Number of patients seen				
30	Outpatient unit	(a) 2002	(b) 2003	(c) 2004	(d) 2005	

0							
01	General OPD	New patients					
		Repeat patients					
		Total visits					
02	Medical OPD	New patients					
		Repeat patients					
		Total visits					
03	Surgical OPD	New patients					
		Repeat patients					
		Total visits					
04	Pediatrics OPD	New patients					
		Repeat patients					
		Total visits					
05	Gyn./obs	New patients					
		Repeat patients					
		Total visits					
06	Health education						
07	Antenatal care (ANC)						
08	Family planning (FP)						
09	Tuberculosis (TB)						
10	(V)CT						

11	ART						
12	PMTCT						
13	HIV/AIDS clinic						
14	Dermato-venorology	New patients					
		Repeat patients					
		Total visits					
15	ENT	New patients					
		Repeat patients					
		Total visits					
16	Dental	New patients					
		Repeat patients					
		Total visits					
17	Ophthalmolo gy	New patients					
		Repeat patients					
		Total visits					
18	Sum the No. of clients reported in columns (a), (b), (c) and (d) separately.	New patients					
		Repeat patients					
		Total visits					
	Types of Inpatient services		Number of patients seen				

30 1	Inpatient unit	(a) 2002	(b) 2003	(c) 2004	(d) 2005	
01	Medical ward					
02	Surgical ward					
03	Pediatrics ward					
04	Gyn./obs ward					
05	Tuberculosis (TB) ward					
06	HIV/AIDS ward					
07	Dermatovenorology ward					
08	ENT ward					
09	Dental ward					
10	Ophthalmology ward					
11	Sum the No. of clients reported in columns (a), (b), (c) (d) separately					
12	In patient days					
	Types of other services	Number of patients seen				
30 2	Other services	(a) 2002	(b) 2003	(c) 2004	(d) 2005	
01	Deliveries					
02	Laboratory tests performed					
03	X-ray tests performed					
04	Major Surgical procedures done					
05	Minor surgical procedures done					
06	Sum the No. of clients reported in columns (a), (b), (c) and (d) separately.					

4. FINANCIAL DATA

	Now I would like to ask you a few questions about financial data of this facility. Ask to see financial reports for the year 2002-2005				
400	Does the hospital's building	Constructed ------------------------------ 1 Purchased ---------------------------------2 Rented --------------------------------------3			➔ 402
401	Total cost of construction/purchase				
402	Annual cost of rent				
403	Number of Beds				
404	Are the following items available today?	(a) YES NO NA	(b) Amount in eth birr	(c) date of purchase	
01	X-ray machine	1 2 3			
02	Ultrasound	1 2 3			
03	Ct scan	1 2 3			
04	ECG/EKG	1 2 3			
05	Spectrophotometer	1 2 3			
06	Elisa reader	1 2 3			
07	CD4 counter	1 2 3			
08	Backup electrical generator	1 2 3			
09	MRI	1 2 3			

10	Ceiling type operation light	1 2 3			
11	Anesthesia apparatus complete	1 2 3			
12	Operating table	1 2 3			
13	Autoclave	1 2 3			
14	Microscope	1 2 3			
15	Centrifuge	1 2 3			
16	Slit lamp	1 2 3			
17	Exophthalmometer	1 2 3			
18	Autorefractor	1 2 3			
19	Lensometer				
20	keratometer				
21	Laser – argon or krypton				
22	ERG (electroretinogram)				
23	Stereopsis plate				
24	Surgical instruments				
25	Washing machine				
26	Vacuum extractor				
27	Doppler fetal heart dectector				
28	Infant incubator				
	Now I would like to ask you a few questions about yearly wages of the following personnel in this facility. Ask to see payroll or financial reports for the year 2002-2005				

	Types of personnel	Yearly wages in eth. birr				
500	**Physicians staff**	(a) 2002	(b) 2003	(c) 2004	(d) 2005	
01	General medical practitioners					
02	Internists					
03	Surgeons					
04	Pediatricians					
05	Gynecologists					
06	Other specialists					
07	Sum the yearly wages reported in columns (a), (b), (c) and column (d) separately.					
501	**Ancillary staffs**					
01	Laboratory technicians					
02	Pharmacy workers (dip+ Bsc)					
03	Radiologist					
04	Sum the yearly wages reported in columns (a), (b), (c) and column (d) separately.					
502	**Administrative staffs**					

Ask to see the following medications and supplies balance sheet for the year 2002 – 2005									
601	Medicines	Unit price paid by the health facility at the time of its last order				Total consumption in Birr			
		2002	2003	2004	2005	2002	2003	2004	2005
01	Paracetamol/acetaminophen tab								

02	Paracetamol susp.								
03	Acetylsilic acid/aspirin oral								
04	Acyclovir oral								
05	Acyclovir ophthalmic								
06	Albendazole oral								
07	Amoxicillin oral								
08	Augmentin oral								
09	Ampicillin injectable								
10	Amphotericin B injectable								
11	Amphotericin pediatric susp.								
12	Bleomycin injectable								
13	Ceftriaxone injectabel								
14	Clotrimazole topical preparations								
15	Clotrimazole vaginal supp.								
16	Ciprofloxacin oral								
17	Chloramphenicol oral								
18	Chloramphenicol injectable								
19	Chloramphenicol susp								
20	Codein oral								
21	Co-trimoxazole susp.								
22	Co-trimoxazole tab								
23	Clarithromycin								
24	Cloxacillin tab / Cloxacillin susp								
25	Dapsone								
26	Dexamthasone								
27	Dextrose 25% or 40% or 50%								
28	Diazepam oral / diazepam injectable								
29	Diclofenac (oral / injectable)								
30	Dipyrone injection								
31	Doxycycline								

32	Ergometrine injectable								
33	Erthromycin								
34	Fluconazole								
35	Folic acid								
36	Ganciclovir								
37	Gentamycin injectable								
38	Gentian violet (GV paint)								
39	Ibuprofen								
40	Indomethacin (supp. / tab)								
41	Iron tablet								
42	Ketoconazole								
43	Loperamide								
44	Mebendazole oral								
45	Methyldopa								
46	Metronidazole oral								
47	Miconazole vag. Tab.								
48	Morphine								
49	Multivitamins								
50	Nalidixic acid oral								
51	Nitrofurantoin oral								
52	Nitrofurazone ointment								
53	Norfloxacin								
54	Nystatin oral / suspension								
55	Nystatin vag. Tab								
56	ORS								
57	Penicillin, benzathine injectable								
58	Penicillin, benzyl injectable								
59	Penicillin, procaine, injectabe								
60	Phenobarbitol								
61	Prednisolone (other steroid)								
62	Silver nitrate eye ointment								

63	Sulfdiazine								
64	Tetracycline								
65	Ttc eye ointment								
66	Tinidazole								
67	Vincristine injectable								
68	Vitamin A								
69	Vitamin B								
70	Xylocaine or lidocaine injectable								
71	Hydrocortisone								
72	Hydralazine								
73	Spectinomycine								
74	Tiabendazole								
75	Omeprazole								
76	Oxytocine								
77	Cemithidine								
78	Antacid susp / tab								
79	Adrenaline								
80	Pethidine								
81	Chlorpromazine								
82	Amitriptline								
83	Valproicacid								
84	Fluicitin								
85	Lithium								
86	Amodiaquine								
87	Chloroquine oral / injectable								
88	Fansidar								
89	Quinine oral / injectable								
90	Prmaquine								
91	Normal saline (0.9% NS)								
92	Dextrose and normal saline (DNS)								
93	Ringers lactate 5%								

94	Plasma expander (any)								
95	AZT+3TC(combivir)								
96	Zidovudine(ZDV,AZT)								
97	Abacavir \ABC								
98	Didanosine\ddl								
99	Efavirenz (EFZ)								
100	Lamivudine\3TC								
101	Nevirapine(NVP)								
102	Tenofovir disoproxi fumarate[Viread]								
103	Protease inhibitors (indinavir[Crixivan], nelfinavir[Viracept],rifonavir[Norvir],saquinavir[invirase]								
104	Stavudine\d4T								
105	Others								

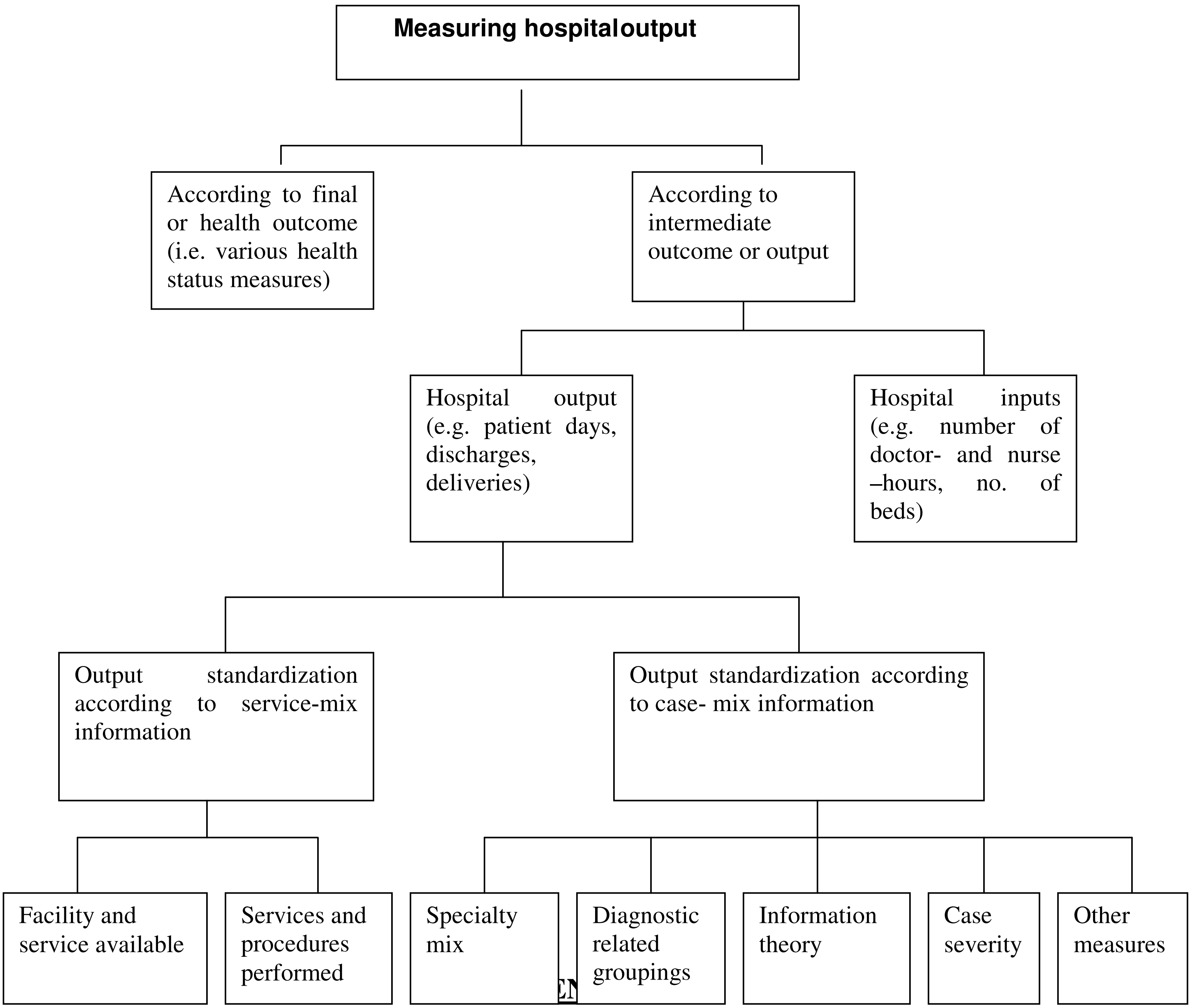
Now I would like to ask you a few questions about yearly budget and expenditure of this facility. Ask to see financial reports on expenditure for the year 2002-2005					
700	Expenditure	2002	2003	2004	2005
1	Total budget				
2	Actual				

	expenditure				
3	Re expenditure				
4	Total				

APPENDIX 2

Hospital out classification

Approaches for Standardizing Hospital Output According to Tatchell (1983)



Regression results for private hospitals

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.901[a]	.812	.697	.55890

a. Predictors: (Constant), IP2, NFOP2, no. of beds, LNPHYPER, SURG, X-ray tests performed, Deliveries, laboratory tests done, NFOPIP, OPD new patient, total number of inpatients

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.318	11	2.211	7.077	.000[a]
	Residual	5.623	18	.312		
	Total	29.940	29			

a. Predictors: (Constant), IP2, NFOP2, no. of beds, LNPHYPER, SURG, X-ray tests performed, Deliveries, laboratory tests done, NFOPIP, OPD new patient, total number of inpatients

b. Dependent Variable: LNC

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12.930	.662		19.534	.000
	Deliveries	-4.08E-05	.001	-.011	-.065	.949
	laboratory tests done	1.586E-05	.000	.343	1.674	.111
	X-ray tests performed	-8.10E-06	.000	-.016	-.126	.901
	no. of beds	3.177E-02	.010	.528	3.227	.005
	LNPHYPER	-.384	.352	-.160	-1.091	.289
	SURG	8.000E-04	.000	.286	1.911	.072
	NFOP2	4.211E-10	.000	.139	.252	.804
	OPD new patient	-5.39E-05	.000	-.523	-.808	.430
	total number of inpatients	-1.25E-03	.001	-1.775	-2.276	.035
	NFOPIP	7.975E-08	.000	1.708	2.126	.048
	IP2	6.334E-08	.000	.544	.856	.403

a. Dependent Variable: LNC

APPENDIX 4

Table 5: Marginal cost and economies scale and scope from statistical cost function

	Study				
Item	Own	Ethiopia	Nigeria	China	Colombia
Marginal Cost (1988 USD)					
Bed day		1.4		7.6	22.0
Outpatient	86.4		2.9	0.5	9.9
Admission			4.2		
Delivery		89.8			
Production returns					
Bed day		1.0		0.7	1.0
Outpatient	3.8		0.8	0.5	0.8
Admission			2.6		
Deliveries		0.9			
Economies of scope					
Bed days and out patient visits	0.4	0.4		0.2	0.1

Source: Barnum and Kutzin (1993) and Own Survey