HOSPITAL COST INFLATION: ECONOMIC APPROACHES
FOR POLICY ANALYSIS

by

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Abstract

The government's failure to contain rapidly increasing hospital costs raises three questions: why costs have risen so rapidly, what policies have been developed and why they have not worked, and what future actions can be taken.

The rapid increase in costs is due to the increase in demand for hospital services. The major component of this increased demand is the growth of insurance coverage. Insurance has substantially removed what little semblance there was of a market mechanism, leading to the rapid expansion of the hospital labor supply and its facilities.

Six legislative control measures were developed to contain rising costs. These included: professional services review organizations (PSRO), certificate of need legislation (CON), manpower reform, coinsurance and deductibles, health maintenance organizations (HMO), and prospective rate setting systems. The CON, PSRO, and manpower approaches attempted to contain costs through direct regulatory controls, while the prospective rate setting, coinsurance and deductibles, and HMO approaches attempted to contain costs by shifting the risk of high costs from the third party reimbursers to hospitals, consumers, and physicians. Major problems with these approaches are explained.

To contain costs in the future, policy makers should address hospital operating efficiency. Two approaches for measuring the effect of hospital size on efficiency in order to determine the most efficient operating size are presented: a statistical cost function approach and a production function approach. The statistical approach, which measures the effect of departmental size on efficiency, produces two results. First, when the patient case is used as the unit of hospital output, efficiency either is unaffected by size or inversely

related to size, depending on which casemix surrogate is used. Second, when the patient day is used as the unit of hospital output, size has no effect on efficiency. These unexpected results are primarily attributed to the absence of a valid measure for casemix differences among hospitals. The production function approach presents an alternative way for measuring the effect of size on efficiency. The major advantage of this approach over the statistical approach is that the results are unaffected by differences in the efficiency with which departments of different sizes combine inputs. Three additional uses of this approach include: the development of average efficiency measures for specific case types, the development of a pricing system for reimbursement purposes, and the development of a basis for establishing specialty hospitals.

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Acknowledgements

Table of Contents

List of Tables and Figures

Introduction

During the past thirty years, the rapid increase in
the cost of hospital care has been unmatched by any other
sector of the economy. As costs continue to rise, policy
makers ask what can be done to contain these costs. In
order to answer this question, three subjects are examined.
In the first chapter, we examine the major reasons for the
increase in the demand for hospital care, the primary cause
for the increase in hospital costs. In the second chapter,
we examine the merits and drawbacks of six policy measures
that have been employed to contain these rising costs. In
the third chapter, we present two approaches for measuring
hospital efficiency; one using a straight forward statistical
analysis, and the other using a production function analysis.
For policy making purposes, these approaches can be used to
determine the most efficient operating size for a hospital.

Chapter 1:   Reasons for Rising Hospital Costs

Between 1950 and 1976, the rapid rise in the cost of
hospital care has been unmatched by any other sector of the
economy.   During this period, the rate of growth in personal
consumption expenditures (unadjusted for inflation) averaged
6.9%, while hospital expenditures have been increasing at
an annual rate of 12.5%.   Since 1966, hospital expenditures
have increased at an annual rate of 16.6% compared to 8.9%
for the entire economy.   Table 1 below compares hospital and
total medical expenditures to total personal consumption ex-
penditures between 1950 to 1976.[1]

Table 1

Medical Care and Hospital Expenditures
Compared with Total Expenditures
in Selected Years

Millions of Dollars ($)

Year	Personal Consumption Expenditures	Medical Care Expenditures	Hospital Expenditures
1950	191,966	9,104	2,030
1955	253,655	13,206	3,197
1960	324,903	20,002	5,307
1965	430,154	30,053	3,419
1966	464,793	32,554	9,358
1967	490,358	35,091	10,733
1968	535,932	38,756	12,385
1969	579,711	44,596	15,242
1970	618,796	49,853	17,903
1971	868,171	54,571	20,399
1972	733,034	61,186	23,303
1973	809,885	68,327	25,920
1974	889,603	76,898	30,123
1975	980,409	90,303	36,106
1976	1,093,950	106,402	43,377
Annual Growth	6.9%	9.9%	12.9%

In order to understand "how" hospital costs have
increased so rapidly, it is necessary to first understand
the underlying causes. The service that a hospital offers
to a patient has undergone a radical transformation in the
last three decades. Rapidly changing technology and im-
proved medical education have altered the entire nature of
a day of hospital care. Therefore, an examination of hos-
pital cost inflation must not only take into account the
increase in the price level for a given set of services,
but also, the change in the character of these services.

Hospital Cost Inflation: Its Causes and Effects

It is generally believed that the increase in hos-
pital costs is primarily due to an increase in the consumers'
demand for hospital services. Because of the changing nature
of these services, this increase in demand must be separated
into a portion which represents a willingness to pay a higher
price for a given amount of care (a shift in the demand curve)
and a portion which represents a willingness to pay a
higher price for an increase in the quality of care (essen-
tially a different demand curve). The increase in the
demand for hospital care has been attributed to five
major reasons: rising personal incomes, changing pattern
of diseases, changing attitudes, changing demographics,
and the growth of insurance coverage.

A study by the National Center for Health Statistics[2]
on the effect of income on the demand for hospital care

indicates that hospital expenditures per capita rose from
$24 in families with incomes under $2000 to $35 in families
with incomes over $10,000. While one of the components of
expenditures per capita, expenditures per patient day,
increases with rising income, the other component, patient
days, decreases with rising income. The decrease in patient
days may be due to a higher quality of care being given to
higher income families.

Table 2

Income and Demand for Hospital Care

Family Income*	Patient Days per 1000 population	Expenditures Per Patient Day	Expenditures Per Capita
Under 2000	117	$20	$24
2000-3999	132	22	29
4000-6999	98	32	31
7000-9999	90	36	32
10,000 and over	83	42	35

* All figures age-adjusted

While the study seems to confirm that rising income
increases hospital expenditures, there are a few minor
problems with the data in the table. First, it is un-
adjusted for case complexity or geographic location.
Second, the statistics are primarily on interview sur-
veys in which respondents are asked to state their ex-
penditures on hospital care, including the part paid by
insurance and the part paid directly. Differences in the

form of insurance coverage of the respondents may have affected estimates on the amount paid by insurance. Finally, the relationship between demand and income, the income elasticity, may be misleading, since those families with the highest health care costs (serious medical candidates) will probably have lower family incomes due to the loss of income while in the hospital.

The changing pattern of disease incidence, along with the improvement in the methods of treatment outside the hospital, have caused a shift in the diagnostic case-mix of hospital admissions.[3] Since 1950, there has been a reduction in the number of patients with infectious and parasitic diseases and an increase in the number with cancer and circulatory diseases. The latter two diseases generally use more hospital days per case although it is unclear if they result in a higher cost per patient day.

The differences in attitudes toward hospital care among different social groups suggests that the increasing educational level and spread of middle class norms have led to an increased demand both for beds and for higher quality care. Additionally, the attitudes of persons in older age groups in 1950 compared with the same age groups in 1979 have changed rapidly, as the perceived role of the hospital has changed.[4]

The changing demographic structure of the population has also influenced the demand for hospital care.

Between 1950 and 1970, people over 65, who use more bed
days per capita than the average-aged person, increased
from 8% to 10% of the population. On the other hand,
people under 25, who use less than the average number
of bed days per capita, increased from 42% to 47% of
the population. Although the weighted average bed days
per capita during this period indicates that the changing
demographic structure had no effect on overall demand
for hospital bed days, this changing demographic struc-
ture may have affected the casemix composition.[5]

Finally, the greatest cause of the increased de-
mand has been the increase in insurance coverage for both
the public and private sectors. The initial effect of
insurance is to lower the net price paid by the patient,
thereby raising his demand for hospital care. Addi-
tionally, the physician, who is considered a "partner" in
the consumer's decision-making process, perceived that
insurance would increase both the patient's ability and his
desire to have more and better medical care; as a
result, the product was changed to one of much higher
quality and expense. Thus, the total increase in the
demand for services can be separated into two parts: a
direct increase in the patient's demand for care, and an
indirect increase in demand resulting from an increase
in the "supply" of care based upon the providers' per-
ception of the expected demand. In effect, insurance

coverage produced a much more expensive product than
consumers in an undisturbed market situation would have
been willing to purchase. Moreover, as the increased
demand for hospital care increased costs, there was a
further demand for insurance coverage; these two demands
reinforced each other spiraling costs upward.

Table 3 below exhibits the growth of insurance
coverage and increased expenditures between 1960 and 1972.[6]

Table 3

Percentage of Hospital Bills Paid by Third Parties and
Expenditure Rate Increases in Selected Years

Year	Percentage of Bill Paid by Third Parties (Fiscal Year)	Percentage Change in Hospital Expense per Adjusted Patient Day	Percentage Change in Hospital Expense per Admission
1960	81.4	7.5	7.5
1965	81.5	7.9	8.7
1966	81.6	7.6	8.6
1967	87.7	13.3	21.2
1968	89.3	12.8	15.2
1969	89.7	15.2	14.4
1970	86.8	14.7	13.1
1971	88.6	13.2	10.6
1972	90.9	13.4	10.4

The leveling off of the third parties' share of the hospital
bill is most likely due to an increase in the price of insur-
ance to the level where the marginal insurance buyer finds it
in his interest to have partial or no insurance coverage (or
use other health plans). The table also reveals that the per-
centage change in the hospital bill per adjusted patient

day increased dramatically when the Medicare and Medicaid
insurance programs were introduced in 1966-67.

In profit-maximizing firms under perfect competi-
tion, the short-run implications of an increase in demand
for a product should be a modest increase in the
supply of output and, depending upon the elasticity of
supply, an increase in the price of the output. In the
long-run, the supply should increase even further and the
price should return to its initial level (this assumes pro-
duction costs remain the same). Applying this theory to
the hospital sector requires one to initially define the
measure of output. Since the product which is offered
by a hospital is quite complex, there are many plausible
definitions of the output measure. Some of them include
the number of treatments, the number of laboratory tests,
the number of "cured" patients, and the number of bed
days. For the sake of discussion, we will arbitrarily
assume that the number of bed days represents the hospital's
unit of output. (Chapter 3 discusses the output measure
further.)

An increase in the demand for the output, bed days,
should initially result in an increase in the hospital's
occupancy rate and then an increase in the supply of
beds. Due to the short-run limitations of increasing
the supply of beds, this increased demand is channelled
into an increase in the bed price. Theoretically, in

perfect markets (assuming profit-maximization), the long-run bed supply should increase and the price per bed should return to its equilibrium level prior to the increase in demand. Most hospitals, though, are not profit-maximizing organizations, but seem to be "service-maximizing" organizations (this is explained in Chapter 3). As a result, this increase in price per bed has taken the form of an increase in salaries, staff size, equipment, and supplies, all of which have led to an increase in the quality of service offered to the patient. In effect, the short-run constraint on bed supply has changed the nature of the product offered to the patient, diminishing the relevance of the output measure, bed days of care. Thus, an increase in the demand for "output" primarily resulted in a new, more expensive product of care rather than an increase in bed days.

A 1977 study by Feldstein and Taylor breaks the increased cost of hospital care into two parts: those resulting from an increase in the number of labor and non-labor inputs, and those resulting from an increase in the price of these inputs.[7] The analysis indicates that about 75% of the increase in the average cost per patient day relative to the general price level has been due to the increase in inputs per patient day, with the remaining 25% due to the increase of input prices relative to the general increase in consumer prices. A breakdown

of these inputs into labor and non-labor components are
shown below.

Nonlabor inputs

Volume of nonlabor inputs	3.15%
Price of nonlabor inputs	0.46%
	3.61%

Labor inputs

Number of employees	1.50%
Earnings per employee	1.05%
	2.55%
Total inputs	6.16%

Summary

In this chapter we have examined the major reasons
for the rapid rise in hospital costs during the past
three decades. Most of this increase is primarily due
to an increase in the demand for hospital services.
Since a decision to obtain medical care requires informa-
tion that is usually too complex for the consumer to
comprehend, this demand is primarily a result of a "joint
decision" between the consumer and the provider of ser-
vices. Thus, the consumer's utility function is determined
by a combination of the provider's perception of the con-
sumer's ability to pay and the consumer's own preferences
based on his ability to pay.

When medical insurance was introduced, most of the con-
straints on both the provider and the consumer were lifted,

removing what small semblance there was of a market struc-
ture. If we assume that the "market treatment" for any
illness remains unchanged, then the increased utilization
of medical insurance should increase the demand for care for
the hospitals' present patient population and for the
population of marginally ill patients, resulting in an
increase in the bed capacity and price per bed. Equili-
brium, for those who are insured, would be reached when
the marginal costs of missing work exceeded the marginal
benefits from hospitalization (the marginal cost also in-
cludes the present value of an increase in the insurance
price due to the current decision of using the hospital).
In actuality, the "market treatment" did change, and the
end result was an increase in both the consumers' demand
and the providers' perception of the consumers' demand for
hospital services; this led to a higher, more expensive
quality of medical care.

Chapter 2: Government Cost Containment Programs Examined

In 1966, with the enactment of Medicaid and Medicare legislation, the federal and state governments made a strong financial commitment to the hospital sector of the economy. Although this legislation increased the availability of better, more comprehensive insurance coverage among the aged and the poor, it also led to a sharp rise in hospital costs (see Table 3 , Chapter 1). In areas where cost increases were the sharpest, Blue Cross premiums also increased, resulting in Blue Cross' fear of being priced out of the market. Similarly, governors and legislators feared that rising costs in Medicaid and other state programs would bankrupt the state treasurees. Finally, those consumers who were insufficiently protected by indemnity-type insurance along with those who were paying rapidly increasing taxes, insurance premiums and their own hospital bills, pressed for government relief and controls. In order to curtail this rapid increase in hospital costs, the federal and state governments considered implementing legislation in six areas. These included: coinsurance and deductibles, health maintenance organizations, certificate of need, professional standard review organizations, manpower, and prospective rate reimbursement. The remainder of this chapter consists of a brief review of each alternative.

Coinsurance and Deductibles

In the past three decades, consumers have increas-
ingly used insurance to diversify the risks of high
hospital costs. Insurance, by lowering the out-of-pocket
costs to each patient, has led to the increased demand
for services and in turn, an increase in total hospital
costs (this is discussed in greater detail in Chapter 1).
One approach which has been proposed to stem the increased
demand created by insurance is to make the patient res-
ponsible for a higher percentage of the cost of care.
This could be done through introducing legislation that
incorporates methods such as coinsurance and deductibles
into current insurance plans.

There has been much debate on how coinsurance
and deductibles affect the demand for hospital services.
Some claim that by placing more risk on the consumer,
coinsurance and deductibles would control expenditures.
Others assert that coinsurance and deductibles aren't
relevant to the patient's demand since the physician
makes the decisions about using medical services[8] (the
specific incentive differences between deductibles and
coinsurance will not be discussed).

Feldstein, in 1973, estimates the gross welfare loss
that would result from increased risk bearing when the
average coinsurance rate for hospital care is increased
from .33 to .67.[9] He calculates this welfare loss by

taking the difference between the increase in the maximum

premium that households would pay to avoid uncertain

expenditures from the corresponding increase in actu-

arial value. A higher coinsurance rate for the popula-

tion as a whole would lower the gross price and reduce

the consumption of services, and in certain circumstances,

reduce the net risk-bearing. Feldstein estimated that

the welfare loss of increased risk bearing with a higher

coinsurance rate ranged from negative amounts to several

billion dollars, depending on the parameters.

A study by Newhouse and Phelps shows that the ex-

penditure elasticity for hospital services is .09 to .10

as a patient's coinsurance decreases from 25% to 0%.[10]

They also cite references to a number of studies, which

based upon diverse data, conclude that coinsurance has had

a negative impact on the utilization of services. An

Arthur D. Little study indicates that high deductibles

and an unlimited ceiling would offset the demand in-

crease that National Health Insurance would have on the

demand for hospital services.[11]

Many problems exist with the theoretical aspects

of the studies on coinsurance and deductibles. The depen-

dent and independent variables which are used in regres-

sion models must clearly be defined in order to meaning-

fully apply their results. For example, the elasticity

function which measures the change in the coinsurance

rate against the change in the demand for hospital

services, must clarify whether the quality of services

remains unchanged and whether the gross price of the

service is constant. When models use length of stay as

a measure of the quantity (the dependent variable), it

biases the estimates of the true quantity-price elas-

ticities because of the correlation with the admissions.[12]

Finally, most coinsurance plans tend to be self-selecting,

whereby those who are healthier choose less costly,

lower coverage plans.[13]

Although many studies indicate that the demand for

hospital care changes as the coinsurance rate changes,

the lack of consensus among the magnitude of demand elas-

ticities presents a serious problem to government legis-

lators whose actions affect an industry with over $100

billion in expenditures. Additionally, a program which

requires copayments and deductibles may impose a heavy

financial burden on low income families. If one as-

sumes that adequate care should be provided to all mem-

bers of society, then a program which covers a large por-

tion of the expenses of low income families must be de-

veloped.

Health Maintenance Organizations (HMOs)

A major objective of national policy over the past

decade has been the development of the Health Maintenance

Organization (HMO). The type of HMO which has received

the most attention during this period has been the pre-
paid group practice in which members pay annual fixed
premiums prior to receiving services.[14] Because of its
profit oriented structure, the success of an HMO depends
on how efficiently it uses its resources. Since the phy-
sician's salary is partially determined by the organi-
zation's profits, the perverse incentive of providing
the highest quality and quantity of care under the fee-
for-service mechanism is removed. Thus, the HMO, as
both the insurer and provider of services, assumes
the risk that previously was held solely by the third-
party insurer.[15]

The initial HMO legislation, P.O. 93-222 (the HMO
Act) was enacted in 1973, establishing priorities for
the development and expansion of health maintenance or-
ganizations. The primary goal of this act was to con-
trol health care costs by giving individuals an oppor-
tunity to join an organization with substantially lower
costs than the traditional system of care. It was anti-
cipated that the development of HMOs would reduce health
care costs in two major ways: emphasis on preventive
care and lowering the hospitalization rates would reduce
the overall health care utilization of HMO members and,
fee-for-service providers and health insurers would be
forced to become more efficient in order to remain compe-
titive.

Studies which compare the costs of HMOs with fee-for-service systems have found that HMOs usually lower each member's health care costs.[16] An early study by Wolfman,[17] comparing the health care costs of families of labor union members enrolled in the Kaiser Foundation Plan of California with those enrolled in Blue Cross Plans, found that Kaiser members had 18% lower total costs. Recently, Hetherington[18] and his associates conducted an extensive study comparing two HMOs and four insurance plans (two Blue Cross plans and two commercial plans), finding that the per person expenses of HMO members were 29% lower than the expenses covered by the commercial plans and 46% lower than the Blue Cross plans. A study by Corbin and Krute,[19] which compared seven HMO proto-types with matched samples of Medicare beneficiaries, found that the HMO members' average costs were between 6% to 34% lower than the costs incurred by non-HMO bene-ficiaries. They also found that HMOs which owned their own hospitals or were at risk for excess hospital costs achieved significant savings.

The major source of the observed cost savings in HMOs was the reduction of inpatient hospital utilization. Reidel[20] found that federal employees enrolled in the Group Health Association of Washington, D.C. spent 319 days in the hospital per 1,000 members compared to 708 days for a comparable group of federal employees enrolled in a Blue

Cross plan. Hetherington[21] and his associates found a
reduction of HMO utilization rates from 30% to 70%
when compared to Blue Cross plans.

Even though HMOs have been able to significantly
reduce hospital utilization rates, they have not been
able to achieve reductions in ambulatory utilization rates.
It has been indicated that the savings from reduced hos-
pital utilization rates are used to provide additional
outpatient care; this additional care is attributed to a
larger proportion of members seeking care rather than
higher utilization among these who are ill.

Despite the huge savings that HMOs seem to offer
their memberships, there are two major problems with the
results of the aforementioned studies. First, there is
no conclusive evidence that HMOs have maintained the same
quality of care while reducing total costs. In theory,
this should not matter since it could be argued that the
patient, who is free to choose his own quality of care,
has opted to sacrifice quality for lower costs. On
the other hand, if the goal of government programs is
to encourage cost controls, with quality basically un-
changed, it will be necessary for studies to incor-
porate a quality measure. Second, the demographics of
the HMO population must clearly be defined. Some pro-
grams restrict their memberships to healthy individuals,
thereby ensuring a lower hospital utilization rate than

that of a random sample of people. This technique, which
is known as "skimming," not only ensures the HMO of lower
than average premiums compared to insurance plans (which
basically have "unbiased" memberships), but it simultane-
ously raises the premiums of these plans (this assumes that
the service offered by providers are equally efficient).

Finally, even with the appeal that HMOs have en-
gendered, certain circumstances have made it very diffi-
cult for new HMOs to enter the market. The mandatory
benefits and operational requirements of the HMO Act
have restrained growth by discouraging private investors
and limiting the availability of federal financial re-
sources. Currently, many states limit the formation of
propietary HMOs. Finally, the average HMO takes five
years to attract enough members to reach break-even opera-
tions and, combined with the uncertainties of the legis-
lative process, this has had negative effects on inves-
tors.[22] In view of the above circumstances, it comes
as no surprise that the development of HMOs has been
quite slow.

Certificate of Need (CON)

Since 1968, one of the principal methods which has
been widely used to limit the costs of hospital care
has been to control the supply of capital.[23] The rationale
for this form of control is that by decreasing the avail-
ability of beds and equipment, lower hospital costs and

utilization will result.

The general approach to regulating the supply of capital was modeled after restrictions imposed on regulated public utilities which required firms to obtain certificates of convenience and public necessity before altering their service capacities. In the hospital sector, certificate of need laws were established requiring hospitals to obtain approval from designated agencies for capital expenditures and expansion of capacity. Although most of these laws were similar in intent, there were many variations in their content. These variations included the standards for review, the types of changes requiring certification, and the nature of the review process.

In 1976, Salkever and Bice[23] examined the impact that CON regulations had on investment patterns and costs in the hospital sector. They performed regression analyses on data from forty-eight states covering the period 1965 to 1972. The results of the study indicated that CON controls had no impact on the total investment by hospitals, but instead, encouraged a redirection of investment from bed expansion towards the growth of new services and facilities. Although this led to lower utilization rates, it increased hospital costs.

The expansion in capital investment, which countervailed the intentions of CON legislation, was attributed to the agency's lack of information and standards about needs for new equipment and facilities. This problem was compounded

by the lack of agency resources which were necessary to
carefully review all certification requests. Additionally,
the validity of the study may be limited by the initial
assumption that CON controls were the only regulatory con-
straint on costs.

The aforementioned results suggest that CON programs
would become more effective if existing controls were tight-
ened and extended to cover all investment projects. This
strategy may result in the costs necessary for the review
process exceeding the costs of the investment projects
being reviewed. By extending the agency's responsibilities
"without" adding resources, decisions that are not in the
public interest may emerge, further exacerbating the problem.
A clear understanding of the incentives which are created
by CON programs is necessary in order to obtain efficient
cost-containment measures.

Professional Standards Review Organization (PSRO)

In 1972, the Social Security Administration enacted
the PSRO law, a peer review concept which was designed to
promote cost consciousness and assure quality maintenance
in federal medical programs.[24] The regulatory body is com-
posed solely of licensed physicians who have the authority
to review medical care provided to patients under the
Medicare, Medicaid, and Maternal and Child Health programs
in a designated geographic area. The physicians determine
whether health care services are medically necessary,

whether they meet professionally recognized standards of
quality, and whether they can be effectively provided on
an outpatient basis or more economically in an inpatient
facility of a different type. Funds for the federal
financing of the above programs cannot be disbursed to hos-
pitals if PSRO disapproves of any of these health care
objectives.

The law mandates that each PSRO apply professionally
developed norms of care, diagnosis, and treatment as the
major points of evaluation and review. Three categories
which include norms, criteria, and standards, were estab-
lished as guidelines for PSRO operations. Norms are de-
fined as reflecting typical practice; criteria are guide-
lines developed for measuring actual practice; and stan-
dards are professional statements of the acceptable range
of deviation from a norm or criteria.

A major problem with the PSRO strategy is that it
is aimed at "waste control" which is not necessarily con-
sistent with cost-containment goals.[25] Since waste control
is usually seen as an elimination of unproductive or counter-
productive care, PSRO actions may have very little effect
on decreasing costs. Another problem with PSRO is that the
norms which are established are developed by physicians who
would be expected to require the best available type of
practice as the expected level of quality. Havighurst
and Blumstein[26] note, "Instead of serving as watchdogs on
behalf of the public at large, PSROs might well become

potent, and virtually unapposed, political instruments for increasing rather than containing costs." Moreover, since the PSRO is composed of physicians who practice predominantly in a fee-for-service environment, it is doubtful that cost-containment strategies which affect their incomes will be pursued. In fact, testimony before the Senate Finance Committee showed that physicians who had a financial interest in a hospital often sat on the utilization review committee.

In summary, PSROs have been given little incentive to contain the rapid rise in hospital costs. The goal of containing costs has basically been changed into the goal of eliminating unproductive and counterproductive care. In order for the PSRO apparatus to function properly, goals must be clearly defined and institutional incentives must be created in order to carry out these goals.

Manpower

In the middle sixties, the increased demand for physicians led the federal government to enact a manpower strategy which increased the physician supply by both increasing the number of medical students and accelerating the training times.[27] The increase in supply led to an increase in hospital utilization rates and subsequently, an increase in total hospital costs. In the past five years, this phenomenom of supply creating demand necessitated a reversal of the initial manpower strategy. The first move

towards a tighter supply was the removal of the rules
which made it easy for foreign medical students to enter
the country. Secondly, there has been increased support
for federal funding of nursing and paraprofessional pro-
grams, whose graduates can perform many of the tasks
currently performed by doctors (thus, wages required for the
same services will be lower). Since no major manpower con-
trol legislation has been enacted, the effectiveness of this
cost-containment strategy is still unknown.

Prospective Rate Setting

In the past twelve years, the most rapidly spreading
form of government regulatory activity has been the stra-
tegy known as prospective rate setting (for this reason,
we will discuss this in detail). About 35 prospective rate
setting systems are currently in operation across the
country under the authority of Blue Cross plans, state com-
missions, and state hospital associations.[28] The hetero-
geneity of these programs is exhibited by the different
methodologies used, the different incentives that are
created, and the different operating styles of the organi-
zations.

Prospective rate setting was developed as a cost-
containment strategy whereby an external authority estab-
lishes rates that hospitals are allowed to change in advance
of the provision of services. The major difference between
prospective rate setting (also known as prospective

reimbursement) and the conventional forms of reimbursement
is that hospitals are not paid the actual costs they incur
in providing services, but are paid a fixed rate for a
specified period of time (usually one year). In effect,
prospective reimbursement shifts a portion of the risk for
hospital costs from the purchaser of services to the hos-
pital administrater, who may be in a better position to
control these costs.

Three major forms of prospective reimbursement have
emerged throughout the country: per case reimbursement, per
diem reimbursement, and fixed revenue reimbursement. A
brief examination of each method facilitates an understanding
of their implications in the hospital sector.

Per Case Reimbursement

Per case reimbursement establishes prospective rates
based on the ratio of approved budget costs to the expected
number of admissions. The budgeted costs are based on
costs from prior years and the costs of peer hospitals
(this actually differs depending on the state). Thus,
hospitals which have economies of scale in their operations
obtain a surplus when the volume of cases during the year
exceeds the budgeted or expected volume. Figure 1, on the
following page, displays this graphically in two ways (other
factors such as casemix, quality, and demographics are
assumed to be constant). This method not only gives hospitals
the incentive to increase their admission rates, but it also

Figure 1

Average and Total Cost Functions For

Per Case or Per Diem Reimbursement *

Average Cost Functions
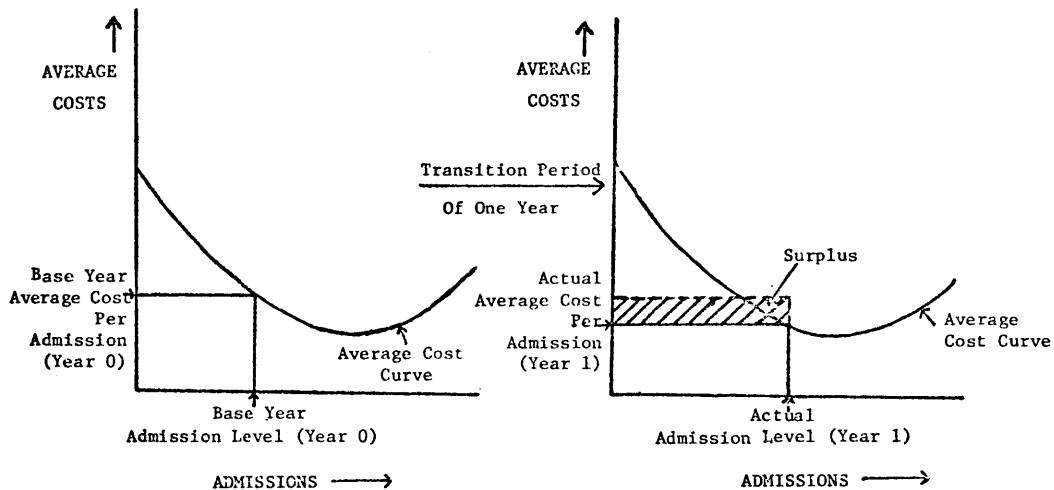
Total Cost Function
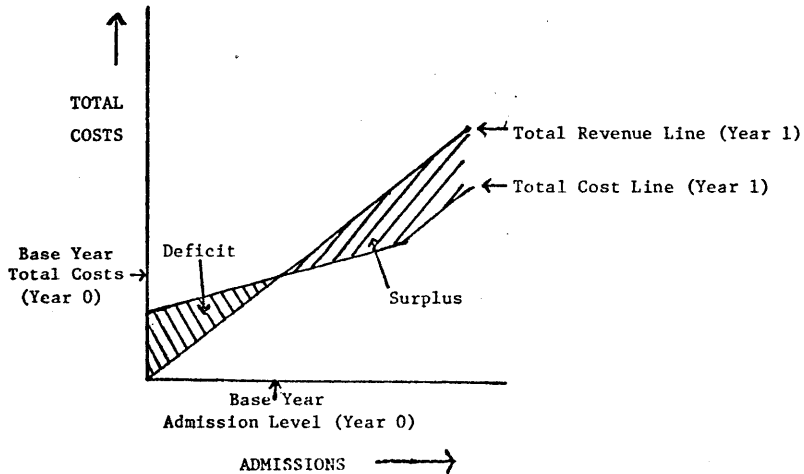
* For Per Diem Reimbursement, substitute PATIENT DAYS for ADMISSIONS

creates an incentive for them to decrease their costs for services. This can be accomplished in three ways: by reducing the service quality, by shifting the casemix for more expensive, complex cases towards less costly simple cases, and finally, by operating more efficiently (this strategy results in surpluses for hospitals with both economies and diseconomies of scale). Additionally, when hospital capacity is reached, admissions can be increased by decreasing the patient's average length of stay.

Per Diem Reimbursement

In a manner similar to per case rate setting, per diem rates are determined by dividing the hospital's approved budget by the expected number of patient days. Thus, by increasing the total number of days and/or decreasing the total operating costs (this is similar to per case rates), the hospital obtains a surplus. Since the marginal cost of an admission is higher than the marginal cost of a patient day, the hospital should increase its total days by decreasing its admissions and increasing its average length of stay per patient.[29] Unused capacity is then filled by increasing the number of admissions. This method is displayed by substituting patient days for admissions in Figure 1.

Fixed Revenue Reimbursement

Fixed revenue reimbursement is a budgeting technique by which hospitals are paid a fixed sum of money for yearly operations; this sum depends on previous years' costs. In

order to obtain a surplus, a hospital will attempt to reduce

its total costs. This could be accomplished in one or more

of the following ways: decreasing the total number of ad-

missions, decreasing the average length of stay, decreasing

the quality of service, simplifying the case mix, and operat-

ing more efficiently. Figure 2, on the following page, dis-

plays the effect of an increase in patient volume in two ways.

Summary of Hospital Strategies Under Three Methods of Reimbursement

In summary, each reimbursement model creates strong

incentives for hospitals to change the character of their

services. The following table summarizes the effects each

model has on hospital services.

Table 4

Theoretical Effects of Three Prospective
Reimbursement Models on Medical Services

	Length of Stay	Cases Treated	Complexity of Mix	Quality	Efficiency
Per Case	Down	Up	Down	Down	Up
Per Diem	Up	Either*	Down	Down	Up
Fixed Revenue	Down	Down	Down	Down	Up

*Explained earlier in per diem section.

Problems with Prospective Rate Setting

Although prospective rate setting gives hospitals

the incentive to reduce costs by being efficient, there are

many drawbacks to the system. As indicated before, the

Figure 2

Average and Total Cost Functions For

Fixed Revenue Reimbursement *

Average Cost Functions

AVERAGE
COSTS

Base Year
Average Cost
Per
Admission
(Year 0)

Average Cost
Curve

Base Year
Admission Level
(Year 0)

ADMISSIONS ⟶

AVERAGE
COSTS

Transition Period
Of One Year

Actual
Average
Costs
(Year 1)

Deficit

Surplus

Average Cost
Curve

Actual
Admission Level
(Year 1)

ADMISSIONS ⟶

Note: "Actual" Surplus = Surplus + Deficit

Total Cost Function

TOTAL
COSTS

Surplus

Base Year
Total Costs
(Year 0)

Total Cost Line (Year 1)

Total Revenue Line (Year 1)

Deficit

Base Year
Admission Level (Year 0)

ADMISSIONS ⟶

* PATIENT DAYS can be substituted for ADMISSIONS

method gives hospitals the incentive to decrease both the quality of care and casemix complexity, neither of which may be desirable. Hospitals under the per diem and per case reimbursement methods are given incentives which may result in inefficiencies. For instance, by increasing the number of admissions or the patient's length of stay, too much "quality" may be thrust upon the consumers. Additionally, the fixed per diem rate schedule penalizes the hospital that gives intensive care for shorter lengths of stay in comparison to the hospital that spreads its service costs over a longer period of hospitalization.

Another problem with prospective rate setting is that it favors hospitals which started the program with low occupancy rates over those with high occupancy rates. Since the initial base rate for low occupancy hospitals is higher than high occupancy hospitals, (assuming economies of scale) a decline to average occupancy would impose losses on the high occupancy hospitals.

Hospitals which started the program operating at efficient levels are penalized the most by the system. Since they have reached their optimum efficiency levels, they can only obtain surpluses by increasing the number of cases or patient days (assuming per diem or per case reimbursement and economies of scale).

Finally, the major flaw in the prospective rate setting theory is that it only deals with the short-run

aspects of a hospital's operations, not the long-run

aspects. Since rates are based on prior years' costs,

lowering one's costs in the rate setting year results in

lower base rates in future years. Thus, even though the

negative incentive of incurring deficits are quite powerful,

the long-run implications of the method encourages a hos-

pital to spend right up to the limit of the permissible

rate.

Studies on Prospective Rate Setting

A cost function study by Applied Management Systems

Incorporated[30] evaluated the prospective rate setting

systems for hospitals in Western Pennsylvania. Prospective

per diem rates were determined by a combination budget

review and formula system, with the latter ensuring that

the approved budget for a hospital is not out of line with

the approved budgets of similar hospitals. The effect

of the prospective system was isolated by comparing five

experimental hospitals (based on a volunteering option)

to control hospitals with similar market characteristics

and standards for medical care.

The results of the evaluation indicated that the rate

of increase in hospital costs under the prospective system

was less than under the conventional system of payment.

The major cost impact seemed to have been on services most

directly under the influence of hospital administrators

rather than on physician controlled service. Due to the

small number of hospitals that particiapted in the experi-
ment and the problem of self-selection bias (hospitals
who volunteered were probably the best able to attain
cost decreases), the results of the experiment must not be
considered as the final word on the combination budget-
review formula method of prospective reimbursement.

In 1974, Hellinger[31] evaluated the impact of pro-
spective reimbursement on hospitals in New Jersey, where
participation in the program was voluntary. The state com-
mission, based on the opinion of an advisory committee and
an analysis of each hospital's budget, set a per diem
rate which was the maximum allowable rate that a hospital
could receive from Blue Cross, Medicaid, and other state-
supported programs. If a hospital incurred costs less
than its budgeted costs, the surplus was rebated to third
party payers. On the other hand, if the actual costs
exceeded budgeted costs, then the hospital absorbed the loss
or appealed to the commission. The methodology used in the
study was similar to the Western Pennsylvania study.

The results of the study indicated that prospective
reimbursement had no significant effect on the average
cost per admission. Additionally, the program did not
lead to a deterioration in the quality of care, a result
which is unexpected based upon the incentives of the
systems. Since many of the hospitals who volunteered for
the program initially were high cost hospitals, a possible

bias in the cost function equation may have occurred.
Finally, the hospitals' success with retroactive adjust-
ments reduced the risk aspects of the prospective system.

Dowling,[31] in a study spanning five years, 1968-
1973, evaluated the prospective rate setting system for hos-
pitals in downstate New York. Between 1968 and 1973 (and
currently), New York was the only prospective system in
the country which set rates solely on the basis of for-
mulas. There was no analysis or comparison of hospital
budgets by the rate setting authorities prior to the
certification of prospective rates. Additionally, there
was no automatic retroactive adjustment after the year,
but hospitals were allowed to appeal the rates set at the
beginning of a year. The cost function methodology used
by Dowling was similar to the previously mentioned studies.

The results indicated that during the five year
period, prospective rate setting successfully lowered hos-
pital costs per patient day. After adjusting for input
price differences and the number of outpatient visits,
the average cost per patient day for downstate hospitals
rose 21% compared to a 39% increase for control hospitals.
This result may be misleading since the per diem system
gives hospitals the incentive to increase the patient's
length of stay, which with hospital economies of scale,
would decrease the average cost per patient day. This
observation is substantiated by Dowling's further research

indicating that the average cost per case in downstate hospitals. increased by 17% compared to an increase of 20% in control hospitals.

The above cost function studies give very inconclusive evidence on the effect prospective rate setting has had on containing hospital costs. Because of the wide diversity of hospitals and the difficulty in identifying key variables to account for these differences, inter-hospital comparisons are very difficult to measure. Moreover, since the output measure for hospitals is very difficult to define, the significance of the regression results is diminished.

The methodology for designing and implementing prospective rate setting programs is still at a relatively primitive stage. Although many problems have arisen since the first program was initiated, it appears that the system has been successful in creating a greater concern among hospital administrators about the financial aspects of theri institutions. As it evolves, prospective rate setting may play a more significant role in cost-containment within the hospital sector.

Summary

In this chapter we have presented six governmental strategies which have been used to contain hospital costs during the past 12 years. Earlier in this thesis (Chapter 1), we indicated that the major reason hospital

costs have risen so rapidly is due to the tremendous
growth of insurance coverage. Insurance has had the
effect of eliminating most of the existing cost contain-
ment incentives for consumers, physicians, and hospital
administrators. Three of the six strategies, prospective
rate setting, coinsurance and deductibles, and health main-
tenance organizations, attempt to recreate some of these
incentives without directly regulating the services that
are offered.

Prospective rate setting was initially designed as
a way of shifting a portion of the risk of hospital costs
from the third parties to the hospital. Theoretically,
by setting rates in advance of services, prospective rate
setting gives hospitals the incentive to operate effi-
ciently in order to obtain a surplus. In practice,though,
the theory created very perverse incentives. These included
increasing the volume of patients and number of patient
days, decreasing the quality of care, simplifying the
casemix, and spending up to the limit allowed by the rates
because of the long-run implications on future rates.
Moreover, since the initial rates may have been only rough
estimates of what the actual rates should have been, year-
end reimbursement adjustments were quite common (this
basically shifts the hospitals' risk back to the third
party payers). Thus, while certain evidence indicates
that prospective rate setting has had some effect on

containing costs, its efficiency implications are unknown.

The second strategy for creating cost-containment incentives is through deductibles and coinsurance. In theory, this strategy would shift a portion of the risk of hospital costs to the consumer, thereby giving both the consumer and physician an incentive to demand fewer services, thus lowering costs (explained in Chapter 1). This proposal, while seemingly quite sound, has met quite a bit of political opposition and has not emerged as a major form of cost-containment.

The third strategy for creating cost-containment incentives has been the Health Maintenance Organization. In this setting, the risk of high health costs is shifted mostly to the physician, since his salary and the organization's survival is determined by how efficiently the group provides services. Additionally, due to its competitive aspects, this form of medical care creates an incentive for hospitals and insurance plans to reduce their costs of providing services. Due to high start up costs, funding problems, and legal restrictions, HMO formation has not become widespread.

The last three strategies, certificate of need, professional standards review organization, and manpower, are forms of regulation which were devised to contain costs through direct control rather than incentives. Certificate of need (CON) is a strategy which was developed to control

the supply of capital in hospitals. The theory of this
approach is based on the belief that by limiting the
supply of equipment and beds, this will result in a de-
crease in the demand for services and subsequent contain-
ment of costs. Actual data indicates that CON has not
contained the total supply of capital but merely shifted
it from beds to equipment and facilities resulting in an
increase in hospital costs. In order for this form of
regulation to be effective, a clear understanding of both
the goals and implications of the regulatory mechanism is
necessary.

Professional Standards Review Organization (PSRO),
is a regulatory device which was designed to contain costs
by determining the necessity of health care services.
Since the regulating body is controlled by physicians,
there is little incentive to reduce the amount of services
that are provided to the patient. The viability of this
form of cost-containment depends on formulating a clear
definition of goals and creating an organization to obtain
these goals.

The final form of regulation which was discussed in
this chapter relates to the control of costs through limiting
the supply of physicians. By controlling the supply,
the total demand for hospital care will be decreased, re-
sulting in a reduction of costs. Since there has been no
major legislation in this area, the effect of this strategy
is still unknown.

The simultaneous existence of all of the afore-
mentioned strategies indicates the complexity of the
problem. It appears that strategies which shift the risks
of health care costs to physicians, consumers, and ad-
ministrators, contain costs more effectively than direct
controls. Whether this is true or not, a clear under-
standing of the product "hospital care" is necessary if
effective and efficient cost-containment measures are to be
obtained. This point is discussed in Chapter 3.

Chapter 3: Analytical Approaches for
Measuring Hospital Efficiency

During the past decade, the government's frantic
attempts to contain hospital costs through various regulatory
mechanisms have been very ineffective. In order to deal with
this problem of accelerating costs, public officials must
establish a rational basis for developing policy.

One factor which should be considered for policy
development is the hospital's operating efficiency. Efficiency,
which is usually measured as the cost per unit of output, can
be examined in several ways. Some of these ways include the
measurement of the effects of size, occupancy rate, caseflow
rate, or average length of stay on average costs. In this
chapter, we will examine hospital efficiency by measuring the
effects of size (or scale) on average costs; the most efficient
hospital size can then be determined. Two approaches which
will be used to measure these effects are the statistical cost
function approach and the production function approach.

Effects of Size on Average Costs

Most economic analyses which measure the size effects
on average costs claim that the resulting average cost curve
has a U-shaped appearance. This shape is attributed to two
effects. First, the division of labor and the spreading out
of overhead cause the cost per unit of output to decline as
size increases. Second, when certain output levels are reached,
the size of the enterprise creates managerial difficulties and

labor inefficiencies causing average costs to rise. These rising costs increase at a faster rate than the declining costs of the first effect.

The average cost curve for hospitals might also be expected to be U-shaped. As hospital size increases, the ease in apportioning the overhead services, linen, maintenance, and cafeteria, would probably cause average costs to decrease. At larger hospital sizes, the problems of controlling a huge staff along with the possible labor inefficiencies would probably cause average costs to rise. Based upon results from the previous paragraph, these managerial diseconomies would be greater than the technical economies.

Statistical Cost Function Approach for Measuring the Effects of Hospital Size on Average Costs

A statistical cost function approach is one way to measure the effects of hospital size on average costs (efficiency). This approach estimates the shape of the average cost curve for hospitals based upon the statistical technique of regression analysis. A major assumption of this approach is that all hospitals operate at their most efficient levels.

Previous statistical cost function studies produced a variety of results; this is due to the different definitions that are used for hospital size and hospital output (these definitions are discussed shortly). A study by Carr and P. Feldstein[33] concludes the existence of economies of scale with long-run average costs reaching a minimum at an average

daily census of 190 and then increasing slightly with scale. Ingbar and Taylor[34] discover an inverted U-shaped cost curve in their analysis, with a maximum at 150 or 200 beds, depending upon the year. H. Cohen[35], in two studies, finds the existence of scale economies with the minimum of the U-shaped cost curve depending upon the measure of output. These minimums occur 150 to 350 beds and 540 to 575 beds. Berry[36] finds the existence of scale economies over the entire range of bedsize. Finally, M. Feldstein[37], finds economies of scale with a minimum cost at 300 or 900 beds depending upon the interpretation of the statistical results (all studies based on long-run costs).

Data Source and Methodology

The data base used for our statistical analysis was obtained from the computer files of the Massachusetts Rate Setting Commission. The analysis is a cross-sectional examination of the 1977 Medical-Surgical departments from ninety hospitals throughout the state. This department was chosen for two reasons. First, the commission, in a 1976 study, obtained very few useful results when all departmental data was lumped together into one data set; thus, an examination by department may be more useful. Second, since most Massachusetts hospitals have Medical-Surgical (MS) departments, a sizeable data base was available. The variables which are used in the analysis appear in the list on the following page (all data is based on a one year period of time).

Variable (CODE)

1. Number of MS Department Beds (BEDS)

2. Expenses of MS Department (NETEXP)

3. Total MS Inpatient Days (TOTIND)

4. Occupancy Percentage (PEROCC)

5. Admissions (ADM)

6. Average Length of Stay (ALOS)

7. Operating Room Times in Minutes (OPRM)

8. Laboratory Tests (LAB)

9. Blood Treatments (BLOOD)

10. Major Teaching Status (MTH)

11. Location in Boston (BOST)

12. Ownership Type - Church (CHURDM)

13. Ownership Type - Municipal (MUNIDM)

14. Percentage of Medicaid Patients (MEDCD)

15. Utilization Rate or Caseflow Rate (CASE)

16. Rehabilitation Hospital (DUMMY)

17. Average Cost Per Unit of Output (AC)

18. Total Beds in Hospital (TOTBED)

19. Total Beds in Hospital Excluding MS Department (OTBED)

20. Average Daily Census (ABEDS)

Since data for a few of the hospital observations was missing (i.e. the sample size for each variable is different), the results of the analysis may be misleading. Any change in the sample size between regressions will be noted in the text.

Additionally, since the data from the computer files was not
screened for errors (by the rate setting commission), our
results may be incorrect.

In order to estimate an average cost function for hos-
pitals, one must select the appropriate measures for hospital
size and hospital output. The studies mentioned previously
measure size in three ways: total beds, average daily census
(beds times occupancy rate), and fully staffed beds. When
total beds is used as the size measure, the resulting average
cost curve may be misleading because of the absence of a factor
for the hospital's occupancy rate. Hospitals with different
occupancy rates would be expected to have different average
costs. A more intuitive measure for size would be the product
of the occupancy rate and the total number of beds which is
called the average daily census. However, even this measure has
its drawbacks since it makes no discrepancy between medical,
surgical, and psychiatric types of beds. If these beds are in-
terchangeable, then they are essentially specifying treatment
capacity in some fixed set of case proportions[38]. Finally, even
when discrepancies are made between different types of beds,
those hospitals with a fixed labor force and low occupancy rates
will bias the average cost curve upward due to the inefficient
use of input capacity and/or a higher quality of patient care.
Thus, it would seem that the most accurate measure for size
would control for unused bed and staff capacity; this is called
the fully staffed beds approach. Due to insufficient data, we

will use both total departmental beds and the average daily census as measures for size (the reasons for using both measures are discussed later).

In order to determine the output that a hospital produces, one must initially define the objective of a hospital. Earlier in this thesis, we stated that the hospital's objective is to maximize the "service" offered to the patient. This general term "service" can be interpreted in a few ways. One interpretation is the maximization of the quality and quantity of services with a maximum acceptable budget deficit.[39] A second interpretation is the maximization of the number of patients treated during a particular period of time, regardless of a budget constraint. A third interpretation is the provision of those services which in turn maximizes the prestige of the institution and the physicians.

Because a hospital's objective can be defined in a variety of ways, different output measures can be proposed. Thus far, four measures of hospital output have emerged from the literature. We will discuss the reasons these measures are used and some of the problems that each presents.

One measure of output is the patient day, which is assumed to be a function of the hospital's supply of labor and capital. Advocates of this measure assume that each day of hospital care requires a fixed amount of resources. Any case-mix variations among hospitals are a function of the length of stay, that is, more complex cases require longer lengths of

stay (resources used per day remain fixed).

A few difficulties arise in using the patient day measure of output for comparing hospital efficiencies. First, hospitals which have an above average treatment intensity per case (assuming similar cases) usually reduce the patients's length of stay, resulting in an upward bias for the efficiency measure, cost per day. Second, this measure fails to consider the differences in the quality of care among hospitals. Third, the patient day is not a specific measure but a gross measure of a variety of hospital services. These include admission-specific, diagnostic-specific, and stay-specific services.[40] Admission-specific services, such as x-ray and laboratory tests, are usually given to each patient regardless of the diagnosis upon admission and the length of stay. A comparison of hospitals with different caseflow rates (the number of cases per bed) and similar casemixes may result in an upward bias in the cost per patient day for hospitals with higher caseflows (total days are the same in this comparison). This means that the marginal cost for an admission is greater than the marginal cost for a patient day (the literature supports this contention). Diagnostic-specific services, such as inhalation therapy, surgical operations, and physical therapy, are not dependent upon the length of stay or the act of admission but on the severity and type of case. A comparison of hospitals which have similar lengths of stay but different

casemixes results in an upward bias in the cost per day measure for hospitals with more complex cases. This upward bias may even occur if the length of stay for more complex cases is longer. Thus, the provision of different types and quantities of labor and capital for different case complexities rejects the assumption that resource inputs per patient day are constant, regardless of casetype. Stay-specific services, such as nursing care, linen service, and meals, are primarily dependent on the patient stay. Of the three service types, this is the only one which substantiates the use of the patient day as the measure for output.

Some of the heterogeneity of the patient day measure can be adjusted for by disaggregating the casetypes into diagnostic categories and then measuring the cost per day of each subgroup classification. Although this approach takes casemix differences into account, a valid patient day measure must still account for the quality of patient care and the service intensity.

A second measure of hospital output is the patient case. Unlike the cost per patient day, the service intensity is an inherent part of the cost per case. However, like the cost per day, this output measure fails to consider differences in the case complexity and the quality of patient care. among hospitals. Either the method in the previous paragraph or the technique of factor analysis can be used to adjust for casemix differences but as of now, no quality measure has

been found.

A third measure of output is the sum of weighted services. One weighted service scheme assigns weights to different hospital services based upon three things: the professional qualifications of the individual performing the service, the severity of the case, and the difficulty of the diagnostic or treatment procedure.[41] Another scheme measures output by assigning weights to different services based on time and cost measures.[42] However, due to the lack of agreement on the proper weights and the failure to consider the quality dimension of care, this output measure has had limited success in obtaining acceptance.

A fourth measure of output is in terms of end results or health levels. This measure is based on the development of hospital specific end-result measures in terms of status alteration and consumer satisfaction.[43] Unfortunately, the difficulties involved in obtaining good health-care measures have limited the use of this form of output for analytical purposes. It appears, though, that future research on developing hospital efficiency measures will needs to consider this output measure.

Due to the existence of readily available data, most studies have used either the patient case or the patient day as output measures. Our data limitations force us into the same situation, and since neither measure offers a clear advantage, both will be incorporated into the analysis.

The average cost variable (our efficiency measure) which is used in the model is the quotient of the total direct expenses for the Medical-Surgical departments and the output measures, patient day or patient case. These direct expenses include purchased services, non-physician staff wages, hospital based physician compensation, supplies' expenses, and major movable equipment depreciation. It should be noted that the absence of building depreciation, the different methods used for allocating equipment depreciation between departments, and the differences in hospital policies for including physicians as paid staff, may bias the results.

To test the hypothesis that the average cost curve for hospitals (in our case departments) is U-shaped, the quadratic average cost function in equation 1 will be used.

$$\text{Average Cost (AC)} = B_o + B_1 \cdot (\text{SIZE}) + B_2 \cdot (\text{SIZE})^2 + \varepsilon \qquad (1)$$

This formula will be used as the basis for developing a model that considers factors which may affect the relationship between size and average costs.

Patient Case as the Output Measure

In the first part of this analysis, the patient case is used as the measure for hospital output. Additionally, size is measured by both total departmental beds and the average daily census (total departmental beds times occupancy rate). Although we previously indicated that the average daily census is an intuitively better measure for size, its use has one problem. One of its factors, the

occupancy rate, is affected by the dependent variable, cost
per case, leading to a possible bias in the regression
results (total bedsize throughout the year is exogenous
since it is unaffected by costs). The statistical technique
of instrumental variable analysis is used to correct this
problem, but unfortunately, no suitable instrumental vari-
able was available for this analysis. Thus, since there
appears to be no clear advantage to either size measure,
both will initially be included in the analysis (the average
daily census measure will be dropped later). Other endo-
genous variables which are used throughout the analysis
include the caseflow rate, the average length of stay, and
the total patient days; they may also bias the results.
(A graph of the average cost per case relative to bedsize
appears in Figure 3).

Estimates of the long-run (year) quadratic average
cost functions using the least squares regression technique
are shown below in equations 2 and 3. The average cost per
case is denoted by AC, while the size variables, total de-
partmental beds and the average daily census, are denoted by
BEDS and ABEDS, respectively. The t-statistics for all of
the variables in this section are listed below their coeffi-
cients.

$$AC_1 = 237.63 + \underset{(2.50)}{1.16 \cdot 10^{-1}} (BEDS) - \underset{(1.73)}{1.00 \cdot 10^{-3}} (BEDS)^2$$

$$R^2 = .09 \qquad (2)$$

Figure 3

Average Costs Per Case Relative to Bedsize

```
2,000 +-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !                                                      !
      !         1                                            !
1,800 +                                                      +
      !                                                      !
      !                                                      !
1,600 +                                                      +
      !                                                      !
      !                                                      !
1,400 +                  1                                   +
      !                                                      !
      !                                                      !
1,200 +                                                      +
Average !                                                    !
Costs   !                                                    !
  Per 1,000 +                                                +
Case    !                                                    !
      !                                                      !
  800 +                                                      +
      !                                                      !
      !              1                                       !
  600 +                       11                          1  !
      !        1           1     1          1                !
      !              2 1 1   2 1 1                            !
  400 +     154 11211 1   11   1   1              1          +
      !     32221325322                                      !
      ! 1 213 1121       1                                   !
  200 + 2 11                                                 +
      !                                                      !
      !                                                      !
    0 +-----+-----+-----+-----+-----+-----+-----+-----+-----+
      0    100   200   300   400   500   600   70.   800   900
```

Bedsize for MS Departments

"Mean" Average Cost Per Case = $401.37
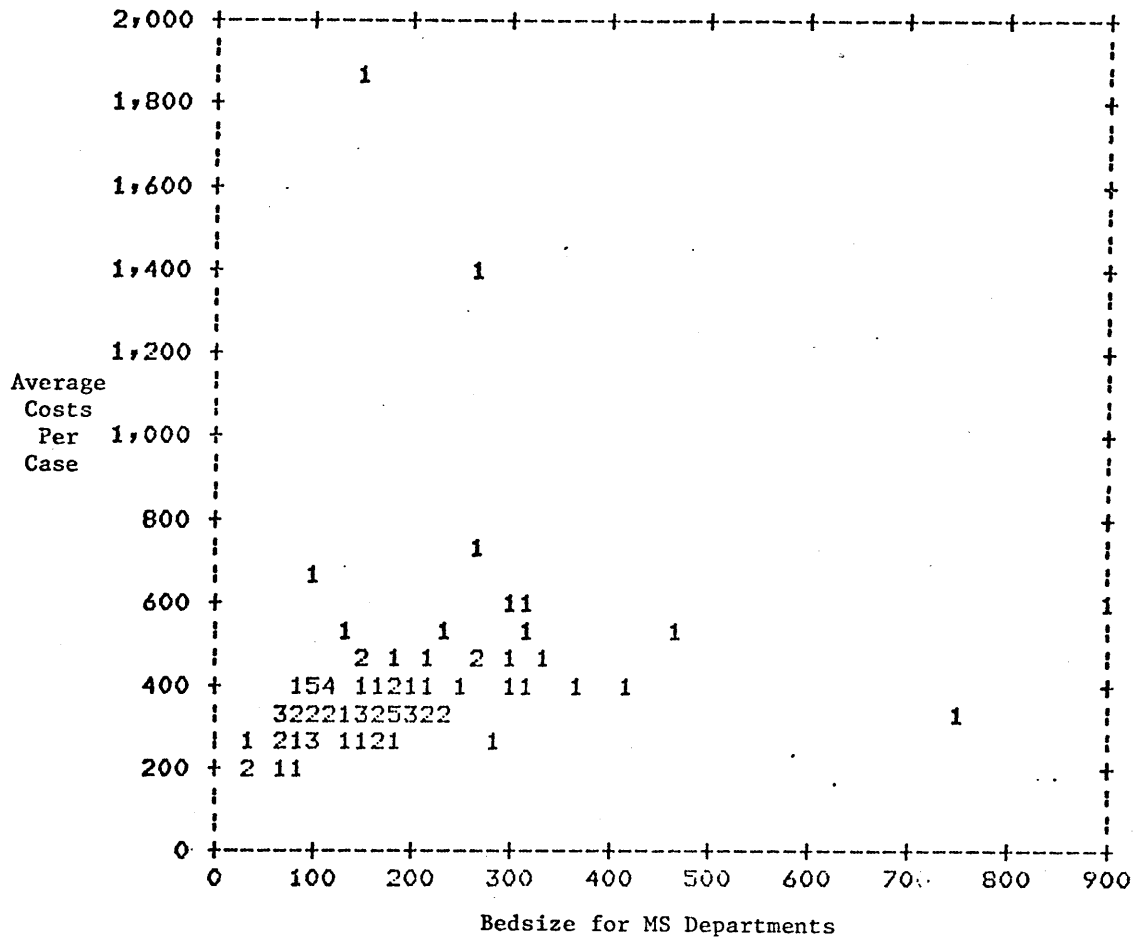
$$AC_2 = 271.56 + 1.03 \cdot 10^{-1} (ABEDS) - 9.64 \cdot 10^{-4} (ABEDS)^2$$
$$(2.28) \qquad\qquad (1.42)$$

$$R^2 = .09 \quad (3)$$

Each equation indicates that the average cost curve
has an inverted U-shape with the maximum average cost
occuring at 583 total beds and 563 "daily census" beds.
However, since the coefficients of the squared terms are
not significant at the 5% level, the belief that average
costs are a quadratic function of bedsize is weakly con-
firmed. When both equations are estimated as linear func-
tions, the coefficients are positive and significant at the
5% level. (The linear functions will be discussed at greater
length later). Additionally, the F-statistics for the above
equations indicate significance at the 1% level (for the re-
mainder of this chapter, assume that the F-statistics for
all equations are significant at the 1% level; most, in fact,
are much more significant).

An examination of the data indicates that there are
two rehabilitation hospitals with high expenses and average
patient stays of more than forty days (all other MS depart-
ments have patient stays of less than fifteen days). As a
result, their average cost per case is quite high. When a
dummy variable for these two hospitals (MS departments) is
included in the model, the following results are obtained.

$$AC_1 = 253.12 + 8.12 \cdot 10^{-1} (BEDS) - 5.87 \cdot 10^{-4} (BEDS)^2$$
$$(3.68) \qquad\qquad (2.14)$$

$$+ 1.23 \cdot 10^3 (DUMMY) \qquad\qquad R^2 = .76 \quad (4)$$
$$(18.79)$$

$$AC_2 = 275.34 + 7.63 \cdot 10^{-1}(ABEDS) - 5.41 \cdot 10^{-4}(ABEDS)^2$$
$$(3.69) \qquad\qquad\qquad (1.67)$$

$$+ 1.24 \cdot 10^3 (DUMMY) \qquad R^2 = .75 \qquad (5)$$
$$(18.69)$$

A comparison of the results of these equations to equations
2 and 3 indicates an increase in the significance of all four
size coefficients, strengthening the belief that average costs
are a quadratic function of size (average costs are also a
function of other variables). The maximum average costs occur
at 691 beds and 705 "daily census" beds, with the former result
statistically more significant. Additionally, the average
cost curves maintain their inverted U-shaped appearances (for
the remainder of this chapter, the "average cost curve" means
a curve which is only a function of size).

The size variable, average daily census, will not be
discussed further for two reasons. First, the regression re-
sults using this measure do not yield any important insights
that are not revealed by the total beds measure (the shape of
the average cost curve and the t-statistics are similar for
both measures). Second, in order to limit the biasedness in
the results, the total beds measure is more appropriate.

Since there are only two MS departments with bedsizes
to the right of the average cost maximizing point (691 beds),
the shape of the average cost curve might be better described
as an inverted-L rather than an inverted-U (the U-shape curve
is predicted by equation 4). In order to verify this suspi-

cion, the MS departments are divided into two sizes, above
and below 160 beds, and equation 4 is applied.

Above 160 beds

$$AC = 207.13 + 1.00 \cdot 10^1 \text{(BEDS)} - 7.35 \cdot 10^{-4} \text{(BEDS)}^2$$
$$ (2.51) \phantom{\cdot 10^1 \text{(BEDS)}} (1.88)$$

$$+ 9.93 \cdot 10^2 \text{(DUMMY)} \qquad\qquad R^2 = .72 \qquad (6)$$
$$(10.31)$$

Below 160 beds

$$AC = -107.55 + 7.98 \cdot 10^0 \text{(BEDS)} - 8.21 \cdot 10^{-2} \text{(BEDS)}^2$$
$$ (3.91) \phantom{\cdot 10^0 \text{(BEDS)}} (3.15)$$

$$+ 1.49 \cdot 10^3 \text{(DUMMY)} \qquad\qquad R^2 = .88 \qquad (7)$$

An examination of the average cost curves predicted by each
equation indicates that in both groups a small number of the
MS departments lie to the right of the cost maximizing point,
yielding curves which appear to have more of an inverted
L-shape than an inverted U-shape. This seems to indicate that
if MS departments with more than 900 beds existed, the level
of the average cost curve in the region of large MS departments
would either remain the same or increase slightly (rather than
decrease as equation 4 predicts). Graphs of the estimated
average cost curves for the entire sample of MS departments
(equation 4) and the two subgroups (equations 6 and 7) are
shown in Figures 4, 5, and 6.

To obtain a more accurate estimation for the shape of the
average cost curve, adjustments should be made for factors which
are associated with size (note: the dummy for rehabilitation
status adjusts larger department AC down). One factor which may

Figure 4

Average Costs Per Case as a Quadratic Function of

Bedsize--Adjusted for Hospital Status
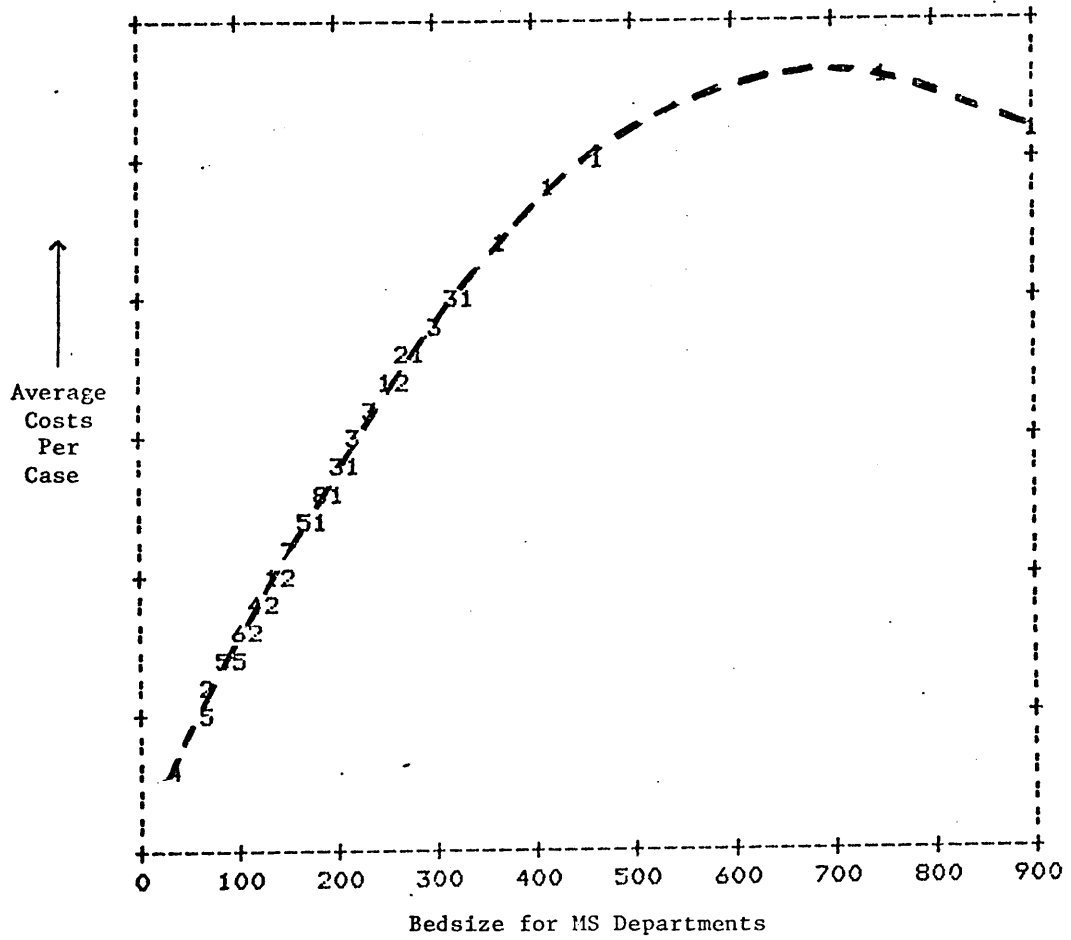

Bedsize for MS Departments

Figure 5

Average Costs Per Case as a Quadratic Function of Bedsize for MS

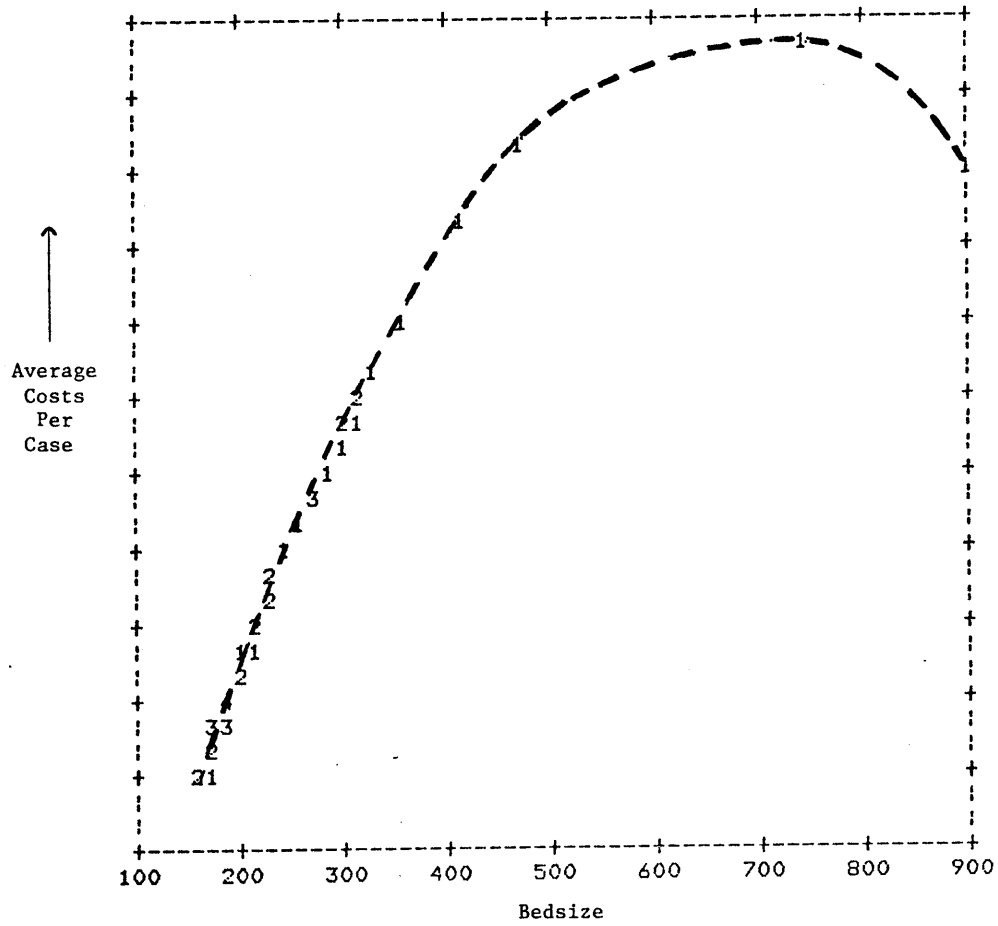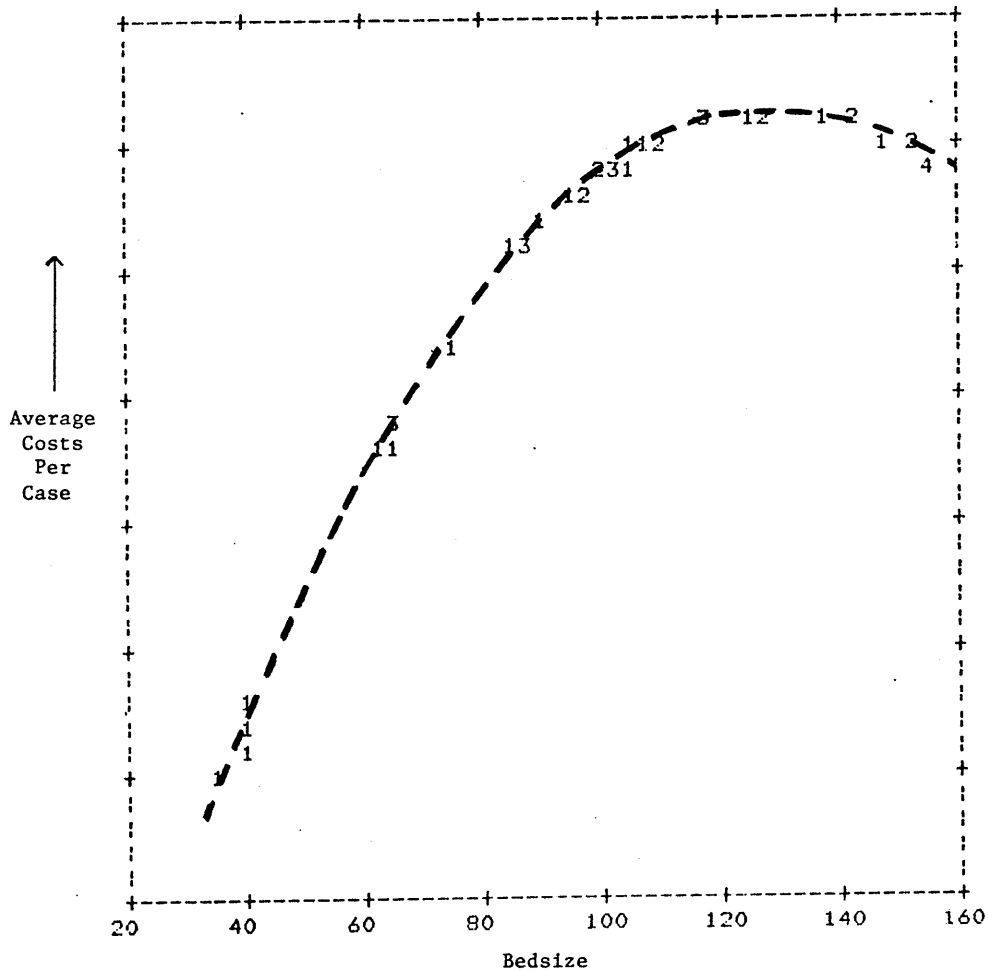Departments Above 160 Beds--Adjusted for Hospital Status

Figure 6

Average Costs Per Case as a Quadratic Function of Bedsize for MS

Departments Below 160 Beds--Adjusted for Hospital Status

affect the shape is the case complexity (casemix) variation among MS departments of different sizes. Because it is infeasible to include every type of case in the regression model, only a small representative sample is used; the technique of factor analysis is used to determine this sample of cases. Since the casetype data necessary to apply this technique was unavailable, three casemix surrogates were considered. One surrogate is the patient's average length of stay. The basis for using this measure is that more complex cases probably require longer average lengths of stay. A second surrogate is the department's caseflow rate which is a measure of the utilization intensity of the department's beds (admissions/beds). The basis for using this measure is that more complex cases probably require longer treatment times, resulting in a lower utilization of beds. A third surrogate for casemix is a linear combination of three ancillary services used by MS patients: laboratory tests, units of blood used in treatment, and operating room time. The basis for using this measure is that more complex cases probably require a greater utilization of ancillary services. These surrogates will be discussed in turn.

If it is true that larger MS departments treat a more expensive, complex set of cases, then the slope of the average cost curve for these larger departments would be biased up-upwards. When the casemix surrogate, average length of stay (ALOS), is added to the model (equation 4) to test if the slope changes, the following result is obtained.

$$AC = 119.99 + 1.85 \cdot 10^{-1} (BEDS) - 6.01 \cdot 10^{-6} (BEDS)^2$$
$$ (0.78) (0.03)$$

$$+ \; 4.00 \cdot 10^2 (DUMMY) + 2.31 \cdot 10^1 (ALOS)$$
$$ (1.85) (4.05)$$

$$R^2 = .84 \qquad (8)$$

The equation indicates that the addition of the ALOS vari-
able dramatically reduces the significance of the two size
coefficients; this is partially due to the correlation
between size and ALOS (correlation is .38). The high statis-
tical significance of the ALOS coefficient is partially due
to the longer patient stays and high average costs of the two
rehabilitation hospitals. Thus, if the average length of stay
is accepted as the casemix surrogate and casemix is a factor
in determining average costs, then from a statistical view-
point the average cost per case is unaffected by the size of
the MS department. Since this result is only statistical, the
possibility that size may affect average costs is still not
ruled out.

When the caseflow rate is used as the casemix surrogate,
the following result is obtained.

$$AC = 504.02 + 5.42 \cdot 10^{-1} (BEDS) - 3.35 \cdot 10^{-4} (BEDS)^2$$
$$ (2.72) (1.37)$$

$$+ \; 1.07 \cdot 10^3 (DUMMY) - 6.78 \cdot 10^0 (CASE)$$
$$ (14.62) (4.37)$$

$$R^2 = .79 \qquad (9)$$

The significance and negative sign of the caseflow coeffi-
cient indicates that more complex cases (lower caseflows) have
a higher average cost, as expected (this is also verified with

the ALOS casemix surrogate in equation 8). Additionally,
when the caseflow rate is controlled for, the slope of the
average cost curve is lowered in the region of the larger
MS departments. This result, however, is only weakly con-
firmed due to the low t-statistic for the squared size co-
efficient.

The third possible casemix surrogate is a linear
combination of the utilization of three ancillary services
(services used by MS patients). These services include
operating room time per admission, units of blood per admis-
sion, and lab tests per admission. When these variables are
added individually or in combinations of two or three to the
model (equation 4), their coefficients and the two size co-
efficients are statistically very insignificant. This result
may be partially due to the low number of observations for each
ancillary service (all were less than 35). Thus, if the linear
combination of ancillary services is accepted as a good surro-
gate for casemix, then the belief that casemix affects average
costs is weakened by the statistical evidence. Additionally,
when casemix is controlled for, average costs are unaffected
by size.

The preceding analyses of the casemix surrogates indicate
that the regression which controls for casemix through the use
of the caseflow variable, exhibits the strongest statistical
evidence that average costs are (in part) a quadratic function
of bedsize. Thus, for further examining the effects of

certain factors on size, the caseflow rate will be used as the measure for casemix complexity. This by no means indicates that the caseflow rate is a better casemix surrogate than the average length of stay or the ancillary service utilization. (Additionally, in order to isolate the effects of certain factors on the shape of the average cost curve, variables will be dropped from the model; this will be noted whenever it occurs).

A second factor which may affect the shape of the average cost curve is the location of the hospital. Hospitals in Boston tend to have larger MS departments than other hospitals in the state, and since Boston hospitals have higher input costs (supplies and labor), the average cost per case would be biased upwards for larger departments. When a dummy variable for Boston hospitals is added to the model, the following result is obtained.

$$AC = 440.90 + 5.81 \cdot 10^{-1} (BEDS) - 3.88 \cdot 10^{-4} (BEDS)^2$$
$$\qquad\qquad\quad (3.41) \qquad\qquad\qquad (1.68)$$

$$+ 8.86 \cdot 10^{2} (DUMMY) - 5.32 \cdot 10^{1} (CASE) + 8.37 \cdot 10^{1} (BOST)$$
$$\quad (10.95) \qquad\qquad\quad (4.00) \qquad\qquad\quad (3.53)$$

$$R^2 = .80 \qquad\qquad (10)$$

The significance and positive sign of the location coefficient adds strong statistical evidence to the belief that the higher input costs for Boston hospitals increases the average cost per case. The increased significance of the size coefficients, compared to equation 9, strengthens the evidence that average costs are a quadratic function of size.

As expected, the addition of the location variable lowers the slope of the average cost curve in the region of the larger MS departments (the low t-statistic on the squared size coefficient weakens this observation).

In order to isolate the statistical effect of location on the shape of the average cost curve, the case-flow rate is dropped from equation. The results appear below.

$$AC = 257.43 + 6.83 \cdot 10^{-1} (BEDS) - 4.53 \cdot 10^{-4} (BEDS)^2$$
$$(3.72) \qquad\qquad (1.98)$$

$$+ 1.01 \cdot 10^3 (DUMMY) + 1.03 \cdot 10^2 (BOST)$$
$$(12.28) \qquad\qquad (4.09)$$

$$R^2 = .76 \qquad (11)$$

The equation indicates, with stronger statistical significance than equation 10, that the slope of the average cost curve is lowered in the region of larger MS departments. The bedsize for the maximum average cost is 753 (compared to 691 for equation 4).

A third factor which may affect the shape of the average cost curve is the teaching status of the hospital. Major teaching hospitals tend to have more equipment and more personnel for each patient than nonteaching hospitals (thus, it is more expensive per patient), and since most teaching hospitals are large institutions, the slope of the average cost curve in the region for large MS departments would be biased upwards. When teaching status is added to the model, its coefficient is very insignificant. The major reason for this is the high correlation between major teach-

ing status and location in Boston.

A fourth factor which may affect the shape of the estimated average cost curve is the occupancy rate. When the caseflow rate is controlled for, an increase in the occupancy rate is equivalent to an increase in the average length of stay (occupancy rate times 365 = ALOS times caseflow rate). Since controlling the caseflow rate is similar to controlling the casemix complexity, an increase in the average stay may be due to either a higher quality of care or an inefficient production of services. Additionally, since the occupancy rate is positively correlated with size (the correlation is .45), the average cost curve in the region for large MS departments would be biased upwards. When the occupancy rate is added to the model, the following result is obtained.

$$AC = 319 + 4.83 \cdot 10^{-1} (BEDS) + 1.76 \cdot 10^{-4} (BEDS)^2$$
$$(0.48) \qquad\qquad (0.21)$$

$$+ 8.11 \cdot 10^2 (DUMMY) - 8.44 \cdot 10^0 (CASE)$$
$$(11.05) \qquad\qquad (6.25)$$

$$+ 8.90 \cdot 10^1 (BOST) + 3.63 \cdot 10^0 (PEROCC)$$
$$(4.23) \qquad\qquad (4.71)$$

$$R^2 = .82 \qquad (12)$$

Although the equation indicates a strong statistical significance for the occupancy rate coefficient, the significance of the size coefficients are very low. Thus, if the occupancy rate is a good indicator of quality or inefficiency, (and therefore, should be included in the model), then the statistical evidence indicates that the average cost per case

is unaffected by size (in the form of a quadratic function).
When ALOS is used instead of occupancy rate, similar statistical results occur.

A fifth factor which may affect the shape of the
average cost curve is the bedsize of the hospital in departments outside the MS department. Based on the present model,
which indicates scale economies, we would predict that increasing the the bedsize for departments outside the MS
department would result in an increase in the average cost
per MS case (this is contrary to the more intuitive expectation of scale economies which was discussed earlier). Since
larger MS departments tend to have larger departments outside
the MS department (correlation = .54), the average cost per
case for larger MS departments would be biased upwards. This
assumes that increasing the size of of the departments outside
the MS department has the the same effect on all sizes of MS
departments. When the variable representing the total number
of beds outside the MS department (OTBED) is added to the model, its coefficient is statistically very insignificant.
However, when the effect of these beds on the shape of the
average cost curve is isolated (caseflow, occupancy, and location are dropped), the result below is obtained. The sample
size is reduced to 74 due to missing data; excluded are the
two rehabilatation hospitals. Therefore, DUMMY is dropped.

$$AC = 252.87 + 1.07 \cdot 10^{0} (BEDS) - 6.95 \cdot 10^{-4} (BEDS)^{2}$$
$$ (4.78) (2.42)$$
$$- 5.13 \cdot 10^{-1} (OTBED)$$
$$(2.67) \phantom{- 5.13 \cdot 10^{-1} (OTBED)......} R^{2} = .33 \qquad (13)$$

The results indicate that when the MS department bedsize is held constant, an increase in the hospital's remaining beds decreases the MS department's average cost per case (when OTBED is excluded the significance of the two BEDS coefficients is very high). This result can be interpreted in two ways. First, an increase in the bedsize of departments outside the MS department creates labor, managerial, and overhead (major movable equipment only, other overhead is not included in costs) efficiencies in the department. Second, the result may be only a statistical association between OTBED and average costs. This second interpretation seems more plausible, since it is contradictory for MS department economies to result from increasing the bedsize outside the department and diseconomies to result from increasing the bedsize inside the department.

A further test for the effects of bedsize outside the MS department on average costs within the department involves the use of the size surrogate, total hospital beds (TOTBED) as the scale measure rather than MS departmental beds (BEDS). This substitution is based on the assumption that most hospitals use beds outside the MS department for treating MS patients. These beds are used because of the patient overflow from very high occupancy rates within the MS department and because of the need to exhibit high occupancy rate in other departments to circumvent certificate of need legislation; this legislation requires the closing of departments with occupancy rates

below a specified level. When total hospital beds are used
as the size measure, the following result is obtained (the
sample is similar to that for equation 13).

$$AC = 274.34 + 4.35 \cdot 10^{-1} (TOTBED) - 1.94 \cdot 10^{-4} (TOTBED)^2$$
$$ (2.51) \phantom{\cdot 10^{-1} (TOTBED) - } (1.22)$$

$$R^2 = .17 \quad (14)$$

Although the statistical evidence is weak, the equation
indicates that the average cost curve is similar to the in-
verted L-shaped curve discussed earlier (only one hospital
lies to the right of the average cost maximizing point of
1159 beds). When the factors discussed previously are con-
trolled for, the regression results are similar to those for
the size variable, BEDS (one difference is that the signifi-
cance of the size coefficients for TOTBED is lower; the same
sample base is used for this comparison).

Even though other factors, such as the type of owner-
ship (church, municipal) and the percentage of patients co-
vered by insurance (Medicaid),[44] may be important in deter-
mining average costs, there is no indication that they are
associated with size. For this reason, they are not included
in the discussion (when each factor is added to the model,
both coefficients are insignificant and the significance of
the other terms' coefficients is reduced). The results of
selected regressions (with size in a quadratic form) appear
in Table 5 on the following page.

Up until this point, we have attempted to show that the

Table 5

Regression Results Based On A Quadratic Average Cost Function

Variables and Coefficients (t-statistic is beneath coefficient)

Regressions	INTERCEPT	BEDS	BEDS^2	DUMMY	CASEFLOW	BOSTON	PEROCC	ALOS	R^2
1	238	1.16 (2.50)	-.00100 (1.79)	--	--	--	--	--	.09
2	235	0.81 (3.68)	-.00059 (2.14)	1231 (18.79)	--	--	--	--	.76
3	120	0.19 (0.78)	-.00001 (0.03)	400 (1.85)	--	--	--	23.12 (4.05)	.84
4	504	0.54 (2.27)	-.00034 (1.37)	1071 (14.62)	-6.78 (9.37)	--	--	--	.79
5	441	0.58 (3.41)	-.00034 (1.68)	886 (10.95)	-5.32 (4.00)	83.71 (3.53)	--	--	.80
6	257	0.68 (3.72)	-.00045 (1.98)	1016 (12.28)	--	103.42 (4.08)	--	--	.76
7	176	0.52 (2.42)	-.00032 (1.28)	1008 (12.37)	--	109.57 (4.31)	1.28 (1.55)	--	.77
8	319	0.48 (0.48)	-.00018 (0.21)	811 (11.05)	-8.44 (6.25)	89.04 (4.23)	3.63 (4.71)	--	.82

Note: All F-statistics indicate confidence levels above 99%. Additionally, without the rehabilitation hospitals in the sample, most of the variation in average costs is explained by caseflow.

average cost per case for MS departments in Massachusetts
is a quadratic function of size (theoretically, a U-shaped
curve). If the "true" curve is U-shaped, and we had chosen
to estimate average costs as a linear function of size, then
the linear term's size coefficient would have been close to
zero. However, if we accept the result that the curve has an
inverted L-shape, a linear cost function estimation would not
be misleading (this assumes caseflow is the casemix surrogate).

As opposed to the quadratic cost function, the linear
cost function permits us to show, with strong statistical
evidence, the cost effects of the factors mentioned earlier.
These effects are displayed graphically in Figure 7 and the
statistical results appear in Table 6. A brief review of
each factor's effect on the slope of the average cost "line"
will aid in understanding the graph. (Additionally, the qua-
dratic average cost curves for the two equations with signi-
ficant (5%) size coefficients are shown in Figure 8).

1. AC=F(BEDS) - the initial unadjusted linear cost
   estimation.

2. AC=F(BEDS,DUMMY) - this controls for two rehabili-
   tation hospitals whose average costs per case
   are much higher than the average MS department.
   Since the two departments are among the larger
   MS departments, the slope is lowered.

3. AC=F(BEDS,DUMMY,CASE) - caseflow is the casemix
    surrogate. Since lower caseflows are associ-
    ated with higher costs and larger hospitals,
    controlling for caseflow lowers the slope.

4. AC=F(BEDS,DUMMY,CASE,PEROCC) - when caseflow is
    controlled for, higher occupancies are simi-
    lar to longer lengths of stay. Since occu-
    pancy rate is highly correlated with size,
    this lowers the slope (using average length
    of stay instead of the occupancy rate has
    the same staistical effect).

5. AC=F(BEDS,DUMMY,CASE,PEROCC,BOST) - since Boston
    hospitals are positively associated with size
    and higher input costs, this lowers the slope.

In summary, in the first part of this section, the

effect of departmental bedsize on the average cost per case

is examined. An average cost curve is estimated as both a

linear and quadratic function of the number of beds in Medi-

cal-Surgical departments throughout Massachusetts. To in-

crease the accuracy of this estimation, the average cost curve

is adjusted for four factors associated with size. These

factors include the hospital status (rehabilitation), the

casemix complexity, the hospital location, and the occupancy

rate. Contrary to the initial belief that the average cost

curve exhibits a U-shape, the results indicate that the curve,

depending on which casemix surrogate is used, either has an

inverted L-shape or is unaffected by size. These unexpected

results are most likely due to the inadequacy of the three

casemix surrogates, the caseflow rate, the average length of

stay, and the ancillary service utilization. The need for a

reliable casemix measure is demonstrated in a study by Feld-

stein[45], whose analysis indicates that the effect of the

Table 6

Regression Results Based on A

Linear Average Cost Function

Variables and Coefficients (t-statistic is beneath coefficient)

	INTERCEPT	BEDS	DUMMY	CASEFLOW	PEROCC	BOSTON	R^2
Regressions							
1	343	0.38 (2.16)	--	--	--	--	.05
2	312	0.34 (4.22)	1244 (17.63)	--	--	--	.75
3	542	0.28 (3.89)	1073 (14.55)	-7.05 (4.56)	--	--	.78
4	382	0.16 (2.02)	1010 (14.32)	-9.24 (6.16)	3.29 (4.06)	--	.80
5	316	0.12 (1.96)	812 (11.15)	-8.23 (6.46)	3.48 (5.09)	89.36 (4.27)	.81

Note: All F-statistics indicate confidence levels above 99%.

Figure 7

Average Costs Per Case as a Linear Function of Bedsize*

Bedsize for MS Departments
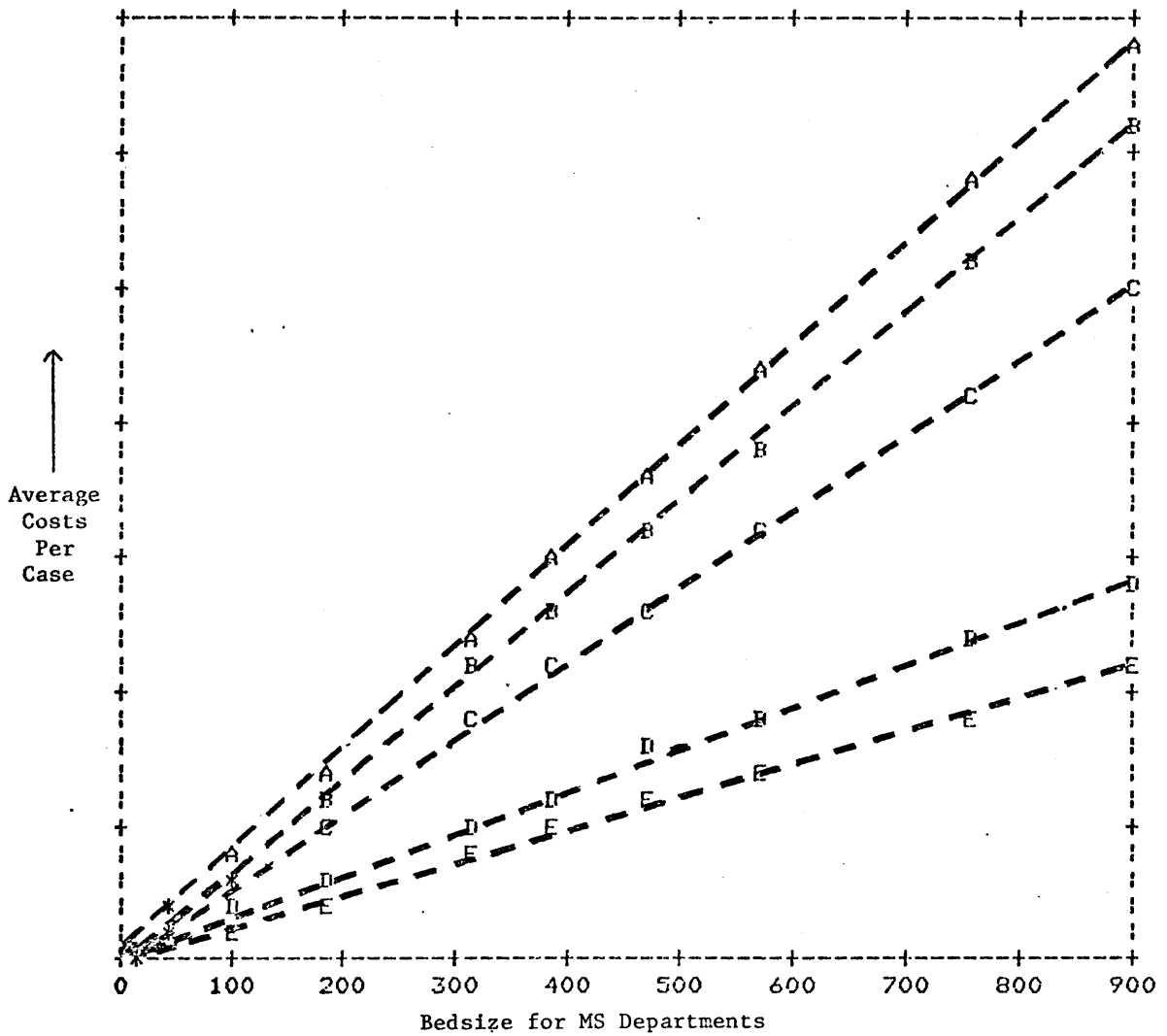
*The Average Cost Lines Were Adjusted for the Following Variables:

A. None
B. Hospital Status
C. Hospital Status, Caseflow Rate
D. Hospital Status, Caseflow Rate, Occupancy Percentagy
E. Hospital Status, Caseflow Rate, Occupancy Percentage,
    Location in Boston

Figure 8

Average Costs Per Case as a Quadratic Function of Bedsize [*]

Bedsize for MS Departments
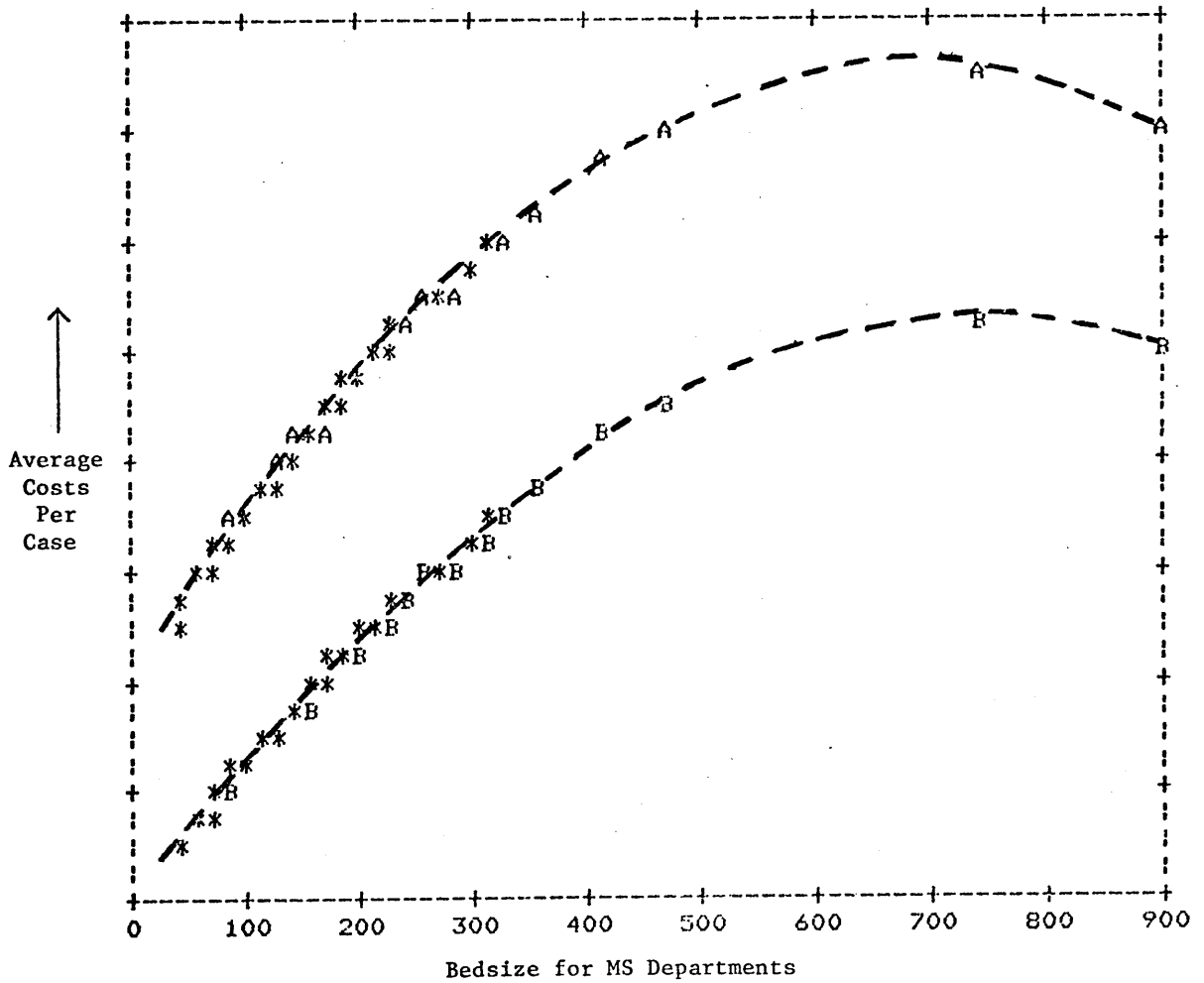
*The Average Cost Lines Were Adjusted For the Following Variables:

A. Hospital Status
B. Hospital Status, Location in Boston

casemix measure is to change the shape of the average cost curve from an inverted L-shape to the expected U-shape.

Even with a good casemix measure, the accuracy of the shape of our estimated average cost curve may be affected in in other ways. First, there may be differences in the quality of care among MS departments. Second, there may be errors in the data base. Third, the use of the endogenous variables, caseflow rate, average length of stay, and occupancy rate, may affect the curve's shape. Fourth, the exclusion of certain overhead items (lighting, cafeteria, and linen services) from total department expenses (they were unavailable) may affect the curve's shape. Fifth, using a statistical approach to estimate the average cost curve assumes that the departments in the sample operate at their most efficient levels. This is highly improbable since the efficiency incentives that exist in most profit-maximizing firms, do not exist in the nonprofit hospital. Therefore, unless the inefficiencies are equally distributed among hospital sizes, the shape of the average cost curve is biased.

Patient Day as the Output Measure

In the second part of this section, the patient day is used as the measure for hospital output. As mentioned earlier, proponents of this measure (in its basic form) assume that the inputs per day are constant and case complexity differences are accounted for by differences in the length of stay. The problems with this rationale will not be reiterated since they

were discussed earlier in the chapter. A graph of the average cost per day relative to bedsize for all MS departments appears on the following page in Figure 9. An estimation of average costs as a quadratic function of size appears below.

$$AC = 38.47 - 1.89 \cdot 10^{-3} (BEDS) + 1.49 \cdot 10^{-5} (BEDS)^2$$
$$(1.11) \qquad\qquad (0.98)$$
$$R^2 = .04 \qquad (15)$$

The equation indicates, with weak statistical significance, that the average cost curve is U-shaped. However, since only two departments lie below the cost minimizing point of 64 beds, most of the curve slopes upwards. When factors which affect average costs are added to the model (same factors in the patient case analysis), there is no improvement in the statistical significance of the size coefficients. An estimation of average costs as a linear function of size results in little statistical improvement (the coefficient indicates diseconomies). Thus, if we accept the patient day as the output measure, the statistical evidence indicates that the average cost per day is unaffected by size (the reasons for these results are similar to those for the patient case results).

The Production Function Approach for Measuring the Effects of Hospital Size on Average Costs

The production function approach is a second way for measuring the effects of hospital size on average costs. Based upon input prices and resource constraints, this approach, also known as the engineering approach, determines the most technically efficient combination of hospital inputs for each level of output. By measuring size as the total output

Figure 9

Average Costs Per Day Relative to Bedsize

```
        90 +-----+-----+-----+-----+-----+-----+-----+-----+-----+
           !                                                      !
           !                                                      !
           !                                                      !
           !                                                      !
        80 +                                                      +
           !                                                      !
           !                                                      !
           !                                                      !
        70 +                                                      +
           !                                                      !
           !                      1                               !
           !                                                      !
Average 60 +                                                      +
Costs      !         1           1   1                            !
Per        !                                                      !
Day        !         1                                            !
        50 +                                                    1 +
           !         2             1                              !
           !         1  1      1 1              1                 !
           !        121 1  1                                      !
           !        21  1                                         !
        40 +        1 111 11 1  1     1                           +
           !        1 2   2   11   1 1                    1       !
           !      2 12 1 315  1         1                         !
           !      1 1 11111112   111 1                            !
           !           1 1112          1                          !
        30 +        1   1 1      1                                +
           !               ·1                                     !
           !                                                      !
           !                                                      !
        20 +-----+-----+-----+-----+-----+-----+-----+-----+-----+
           0    100   200   300   400   500   600   700   800   900
```

Bedsize for MS Departments
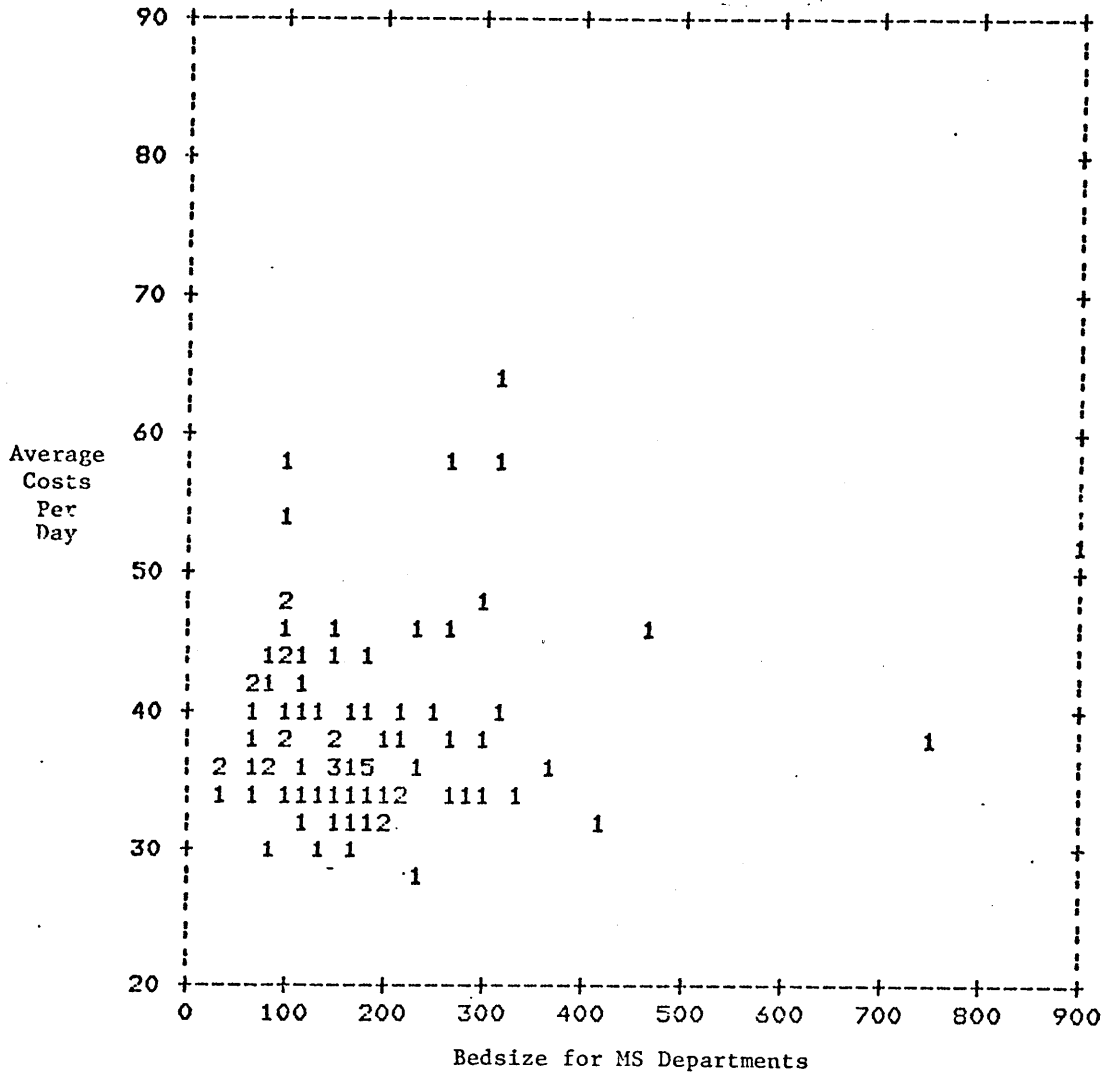
"Mean" Average Cost Per Day = $39.41

of the hospital (as opposed to the "beds" measure used for the statistical approach), one can develop an average cost curve which exhibits the effects of size on efficiency. The major advantage of this approach over the statistical spproach is that the results are unaffected by differences in the efficiency with which hospitals of different sizes combine inputs; if larger hospitals are less efficient than smaller ones, the average cost function obtained by the statistical approach would underestimate economies of scale, while the production function approach would not.

Although this approach is quite appealing, it has one apparent problem. The traditional assumption that one output is determined as a function of a set of input factors is not applicable for hospitals. Hospital inputs, including nurses, doctors, housekeeping, and capital, are used to produce many different outputs, not just one. Two production function studies by Dowling and M. Feldstein attempt to deal with this problem.

Dowling's study[46] concentrates on the production of medical services for inpatient care, with the output measured by the patient case load. This load is decomposed into 55 diagnostic categories and each category is equally weighted on the assumption that a hospital attempts to maximize the total number of patients treated. Dowling circumvents the multiproduct problem mentioned earlier by assigning to each diagnostic category a well-defined input service mix in terms of nursing days, prescriptions, doctors, laboratory tests, among others.

He uses a linear programming approach and assumes that the input coefficients for each diagnostic category are fixed.

Dowling's final model finds that the output measure, diagnosis specific patient days, is a function of five departmental inputs: nursing days, laboratory, radiology, delivery rooms, and operating rooms. His major conclusion is that the study hospital operated at from 74.5% to 85.1% of optimum efficiency. Thus, a reallocation of resources would have allowed the hospital to treat more patients without exceeding capacity.

Although Dowling's approach is quite attractice, it has a number of drawbacks. One problem is his lack of inclusion of the quality dimension of medical care. Second, the input assignments may be biased estimates of the actual inputs. Third, the matrix of coefficients may not be fixed for all output levels (this problem can be overcome by approximating non-linear functions by linear segments). Fourth, the hospital usually does not have complete control over the casemix of patients, limiting the use of his results. Fifth, there is a problem with accepting the definition of the objective function as the maximization of the number of treated patient days.

Feldstein's approach[47] for estimating a production function is more in line with such traditional approaches as the Cobb-Douglas function and Leontif fixed-proportion function. He defines the hospital's output as the sum of weighted case categories, using the relative average costs as weights for each casetype. Then, using the approaches mentioned above, he

obtains a "general" production function which estimates the
input elasticities of five factors: beds, nurses, occupancy
rate, drugs and dressings, and doctors. Three major results
emerge from the analysis. First, there are slight decreasing
returns to scale. Second, output increases if a greater pro-
portion of total expenditures are devoted to medical staff
and less to nursing and housekeeping activities. Third, the
effect of substituting medical staff for nursing is more
substantial in larger hospitals. Feldstein's study, like
Dowling's, fails to consider the quality aspects of his output
measure and he may have also defined this measure incorrectly.

In addition to determining the effects of size on
efficiency, the production function approach can have other
applications. One is to determine how efficiently a parti-
cular hospital treats a specific type of case. Hospitals
with similar characteristics would be grouped together, and
the resulting efficiency measures for this particular case
would be combined to obtain an "average" efficiency measure.
This procedure would be followed for each casetype and the
results would then be made available to hospitals to help
them in planning their resource allocations. A second use is
for reimbursement purposes. The most efficient combination
of inputs for each type of case would be determined, and then
based on market prices for each location within the state, a
price for each type of case would be set. A final use would
be to apply a linear programming model to a group of hospitals

within a particular area to determine which hospitals treated each casetype in the most efficient way. Public policy would then be set so that each hospital would specialize in the cases it treated most efficiently.

Summary

In this chapter, we present two approaches for studying operating efficiency: the statistical cost function approach and the production function approach. Based upon the expectation that the average cost curve for hospitals is U-shaped (from traditional economic theory), we employ the statistical approach to determine the most efficient operating size for Medical-Surgical departments in Massachusetts. The results indicate that when the patient case is used as the output measure, the average cost curve has either an inverted L-shape or is unaffected by size, depending upon which casemix surrogate is used. When the patient day is used as the output measure, average costs are unaffected by size. The discrepancy between these results and the expected U-shaped curve is attributed to the inadequacies of our casemix surrogates.

A second approach for determining the most efficient operating size for a hospital is through the development of a production function. The major advantage of this approach over the statistical approach is that the results are unaffected by differences in the efficiency with which hospitals of different sizes combine inputs. For example, if larger

hospitals are less efficient than smaller ones, the average cost function obtained by the statistical approach would underestimate economies of scale, while the production function approach would not. Additional production function applications include: developing an average efficiency measure for each case type, developing a pricing system for each case type, and developing a basis for establishing specialty hospitals.

Chapter 4:   Conclusion

As hospital costs continue their rapid acceleration, policy makers continue to ask what can be done.   In this thesis, we have approached this question in three ways. First, we examined the reasons why hospital costs have increased so rapidly in the past thirty years.   Second, we presented the merits and drawbacks of existing government cost-containment programs.   Third, we showed how analytical techniques can be used to develop efficiency measures for cost-containment purposes.   In summing up the dilemma on hospital cost inflation, we quote a 1972 statement by Berki[48]:

> "We may not know what it is exactly, or how its production or distribution are brought about, but at the yearly cost of some $70 billion, of which the largest single component, about $30 billion, is hospital cost, something called medical care is produced and distributed. There certainly appears to be a demand for it."

Today, only the numbers have changed.

Footnotes

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