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.

Thesis Supervisor: Stan Finkelstein
Assistant Professor
Sloan School of Management
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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 straightforward 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 expenditures between 1950 to 1976.

Table 1
Medical Care and Hospital Expenditures Compared with Total Expenditures in Selected Years

<table>
<thead>
<tr>
<th>Year</th>
<th>Personal Consumption Expenditures</th>
<th>Medical Care Expenditures</th>
<th>Hospital Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>191,966</td>
<td>9,104</td>
<td>2,030</td>
</tr>
<tr>
<td>1955</td>
<td>253,655</td>
<td>13,206</td>
<td>3,197</td>
</tr>
<tr>
<td>1960</td>
<td>324,903</td>
<td>20,002</td>
<td>5,307</td>
</tr>
<tr>
<td>1965</td>
<td>430,154</td>
<td>30,953</td>
<td>3,419</td>
</tr>
<tr>
<td>1966</td>
<td>464,793</td>
<td>32,554</td>
<td>9,358</td>
</tr>
<tr>
<td>1967</td>
<td>490,358</td>
<td>35,091</td>
<td>10,733</td>
</tr>
<tr>
<td>1968</td>
<td>535,932</td>
<td>38,756</td>
<td>12,385</td>
</tr>
<tr>
<td>1969</td>
<td>579,711</td>
<td>44,596</td>
<td>15,242</td>
</tr>
<tr>
<td>1970</td>
<td>618,796</td>
<td>49,853</td>
<td>17,903</td>
</tr>
<tr>
<td>1971</td>
<td>868,171</td>
<td>54,571</td>
<td>20,399</td>
</tr>
<tr>
<td>1972</td>
<td>733,034</td>
<td>61,186</td>
<td>23,303</td>
</tr>
<tr>
<td>1973</td>
<td>809,885</td>
<td>68,327</td>
<td>25,920</td>
</tr>
<tr>
<td>1974</td>
<td>889,603</td>
<td>76,898</td>
<td>30,123</td>
</tr>
<tr>
<td>1975</td>
<td>980,409</td>
<td>90,303</td>
<td>36,106</td>
</tr>
<tr>
<td>1976</td>
<td>1,093,950</td>
<td>106,402</td>
<td>43,377</td>
</tr>
</tbody>
</table>

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 improved medical education have altered the entire nature of a day of hospital care. Therefore, an examination of hospital 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 hospital 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 (essentially 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 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

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

* 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 surveys in which respondents are asked to state their expenditures 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. 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.

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 structure may have affected the casemix composition.  

Finally, the greatest cause of the increased demand 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. Additionally, 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' perception 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

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

The leveling off of the third parties' share of the hospital bill is most likely due to an increase in the price of insurance 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 percentage 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 competition, 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 production 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. 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 information 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 services. Thus, the consumer's utility function is determined by a combination of the provider's perception of the consumer's ability to pay and the consumer's own preferences based on his ability to pay.

When medical insurance was introduced, most of the constraints on both the provider and the consumer were lifted,
removing what small semblance there was of a market structure. 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. Equilibrium, 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 includes 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 treasuries. 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 increasingly 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 responsible 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 (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. 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 actuarial value. A higher coinsurance rate for the population 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 expenditure elasticity for hospital services is .09 to .10 as a patient's coinsurance decreases from 25% to 0%.\textsuperscript{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 increase that National Health Insurance would have on the demand for hospital services.\textsuperscript{11}

Many problems exist with the theoretical aspects of the studies on coinsurance and deductibles. The dependent and independent variables which are used in regression models must clearly be defined in order to meaningfully 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 elasticities 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 elasticities presents a serious problem to government legislators 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 assumes that adequate care should be provided to all members of society, then a program which covers a large portion of the expenses of low income families must be developed.

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 prepaid group practice in which members pay annual fixed premiums prior to receiving services.\textsuperscript{14} Because of its profit oriented structure, the success of an HMO depends on how efficiently it uses its resources. Since the physician's salary is partially determined by the organization'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.\textsuperscript{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 organizations. The primary goal of this act was to control health care costs by giving individuals an opportunity to join an organization with substantially lower costs than the traditional system of care. It was anticipated 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 competitive.
Studies which compare the costs of HMOs with fee-for-service systems have found that HMOs usually lower each member's health care costs. An early study by Wolfman, 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 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, which compared seven HMO prototypes 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 beneficiaries. 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 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 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 hospital 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 those 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 unchanged, it will be necessary for studies to incorporate a quality measure. Second, the demographics of the HMO population must clearly be defined. Some programs 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 simultaneously 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 engendered, certain circumstances have made it very difficult 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 resources. Currently, many states limit the formation of proprietary HMOs. Finally, the average HMO takes five years to attract enough members to reach break-even operations and, combined with the uncertainties of the legislative process, this has had negative effects on investors. 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. The rationale for this form of control is that by decreasing the availability 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 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 counteracted 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 constraint on costs.

The aforementioned results suggest that CON programs would become more effective if existing controls were tightened 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. The regulatory body is composed 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 hospitals 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 established as guidelines for PSRO operations. Norms are defined as reflecting typical practice; criteria are guidelines developed for measuring actual practice; and standards 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 consistent with cost-containment goals. Since waste control is usually seen as an elimination of unproductive or counterproductive 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 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. 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 phenomenon 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 programs, 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 control 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 strategy 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 commissions, and state hospital associations. The heterogeneity of these programs is exhibited by the different methodologies used, the different incentives that are created, and the different operating styles of the organizations.

Prospective rate setting was developed as a cost-containment strategy whereby an external authority establishes 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 hospital administrator, 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

<table>
<thead>
<tr>
<th>Transition Period</th>
<th>Of One Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year</td>
<td>Admission Level (Year 0)</td>
</tr>
<tr>
<td>Base Year</td>
<td>Admission Level (Year 1)</td>
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<tr>
<td>Admission Level (Year 0)</td>
<td>Admission Level (Year 1)</td>
</tr>
<tr>
<td>ADMISSIONS</td>
<td>ADMISSIONS</td>
</tr>
</tbody>
</table>

Total Cost Function

<table>
<thead>
<tr>
<th>Total Revenue Line (Year 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost Line (Year 1)</td>
</tr>
<tr>
<td>Deficit</td>
</tr>
<tr>
<td>Surplus</td>
</tr>
<tr>
<td>ADMISSIONS</td>
</tr>
</tbody>
</table>

* 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 admissions, decreasing the average length of stay, decreasing the quality of service, simplifying the case mix, and operating more efficiently. Figure 2, on the following page, displays 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

Total Cost Function

* 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 hospital 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 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 participated in the experiment 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 evaluated the impact of prospective reimbursement on hospitals in New Jersey, where participation in the program was voluntary. The state commission, 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 adjustments reduced the risk aspects of the prospective system.  

Dowling, in a study spanning five years, 1968-1973, evaluated the prospective rate setting system for hospitals 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 formulas. 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 hospital 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 their 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 containment incentives for consumers, physicians, and hospital administrators. Three of the six strategies, prospective rate setting, coinsurance and deductibles, and health maintenance 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 efficiently 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 decrease in the demand for services and subsequent containment 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, resulting 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 aforementioned strategies indicates the complexity of the problem. It appears that strategies which shift the risks of health care costs to physicians, consumers, and administrators, contain costs more effectively than direct controls. Whether this is true or not, a clear understanding 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\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{36} finds the existence of scale economies over the entire range of bedsize. Finally, M. Feldstein\textsuperscript{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 hospitals, 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 interchangeable, then they are essentially specifying treatment capacity in some fixed set of case proportions\textsuperscript{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. 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. Another scheme measures output by assigning weights to different services based on time and cost measures. 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. 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.

\[
\text{Average Cost (AC)} = B_0 + B_1 \cdot (\text{SIZE}) + B_2 \cdot (\text{SIZE})^2 + \epsilon \quad (1)
\]

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 variable 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 endogenous 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 departmental 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 coefficients.

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

$$R^2 = 0.09$$

(2)
Figure 3
Average Costs Per Case Relative to Bedsize

"Mean" Average Cost Per Case = $401.37
AC_2 = 271.56 + 1.03 \cdot 10^{-1} (ABEDS) - 9.64 \cdot 10^{-4} (ABEDS)^2
\quad (2.28) \quad (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 occurring 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 confirmed. When both equations are estimated as linear functions, 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 remainder 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 departments 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
\quad (3.68) \quad (2.14)
+ 1.23 \cdot 10^3 (DUMMY)
\quad (18.79)
R^2 = .76 \quad (4)
\[
AC_2 = 275.34 + 7.63 \cdot 10^{-1} (ABEDS) - 5.41 \cdot 10^{-4} (ABEDS)^2
\]
\[
+ 1.24 \cdot 10^3 \text{ (DUMMY)} \quad R^2 = .75 \quad (5)
\]

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

Above 160 beds
\[
AC = 207.13 + 1.00 \cdot 10^{1} \text{(BEDS)} - 7.35 \cdot 10^{-4} \text{(BEDS)}^2
\]
\[
(2.51) \quad (1.88)
\]
\[
+ 9.93 \cdot 10^{2} \text{(DUMMY)}
\]
\[
(10.31)
\]
\[
R^2 = .72 \quad (6)
\]

Below 160 beds
\[
AC = -107.55 + 7.98 \cdot 10^{0} \text{(BEDS)} - 8.21 \cdot 10^{-2} \text{(BEDS)}^2
\]
\[
(3.91) \quad (3.15)
\]
\[
+ 1.49 \cdot 10^{3} \text{(DUMMY)}
\]
\[
R^2 = .88 \quad (7)
\]

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
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 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.
\[ AC = 119.99 + 1.85 \times 10^{-1} (\text{BEDS}) - 6.01 \times 10^{-6} (\text{BEDS})^2 \\
\hspace{1cm} (0.78) \hspace{1cm} (0.03) \\
+ 4.00 \times 10^2 (\text{DUMMY}) + 2.31 \times 10^1 (\text{ALOS}) \\
\hspace{1cm} (1.85) \hspace{1cm} (4.05) \\
R^2 = .84 \hspace{1cm} (8) \]

The equation indicates that the addition of the ALOS variable 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 statistical 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 viewpoint 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.

\[ AC = 504.02 + 5.42 \times 10^{-1} (\text{BEDS}) - 3.35 \times 10^{-4} (\text{BEDS})^2 \\
\hspace{1cm} (2.72) \hspace{1cm} (1.37) \\
+ 1.07 \times 10^3 (\text{DUMMY}) - 6.78 \times 10^0 (\text{CASE}) \\
\hspace{1cm} (14.62) \hspace{1cm} (4.37) \\
R^2 = .79 \hspace{1cm} (9) \]

The significance and negative sign of the caseflow coefficient 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 confirmed due to the low t-statistic for the squared size coefficient.

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 admission, 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 coefficients 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 surrogate 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.

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

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

\[R^2 = .80\] \hspace{1cm} (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.

\[
AC = 257.43 + 6.83 \cdot 10^{-1} \text{(BEDS)} - 4.53 \cdot 10^{-4} \text{(BEDS)}^2 \\
\quad (3.72) \quad (1.98)
\]

\[
+ 1.01 \cdot 10^3 \text{(DUMMY)} + 1.03 \cdot 10^2 \text{(BOST)} \\
\quad (12.28) \quad (4.09)
\]

\[R^2 = .76\]

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-
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.

\[
AC = 319 + 4.83 \cdot 10^{-1} \text{(BEDS)} + 1.76 \cdot 10^{-4} \text{(BEDS)}^2 \\
+ 8.11 \cdot 10^2 \text{(DUMMY)} - 8.44 \cdot 10^0 \text{(CASE)} \\
+ 8.90 \cdot 10^1 \text{(BOST)} + 3.63 \cdot 10^0 \text{(PEROCC)} \\
\]

\[
R^2 = .82 \quad (12)
\]

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 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 the departments outside the MS department has 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 rehabilitation hospitals. Therefore, DUMMY is dropped.

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

\[ AC = 274.34 + 4.35 \times 10^{-1} \text{(TOTBED)} - 1.94 \times 10^{-4} \text{(TOTBED)}^2 \]

\[
(2.51) \\
(1.22)
\]

\[ R^2 = .17 \quad (14) \]

Although the statistical evidence is weak, the equation indicates that the average cost curve is similar to the inverted 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 controlled for, the regression results are similar to those for the size variable, BEDS (one difference is that the significance 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 ownership (church, municipal) and the percentage of patients covered by insurance (Medicaid), may be important in determining 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)

<table>
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<tr>
<th>Regressions</th>
<th>INTERCEPT</th>
<th>BEDS</th>
<th>BEDS²</th>
<th>DUMMY</th>
<th>CASEFLOW</th>
<th>BOSTON</th>
<th>PEROCC</th>
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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 quadratic average cost curves for the two equations with significant (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 rehabilitation 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 associated 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 similar to longer lengths of stay. Since occupancy rate is highly correlated with size, this lowers the slope (using average length of stay instead of the occupancy rate has the same statistical 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 Medical-Surgical departments throughout Massachusetts. To increase 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 Feldstein, 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)

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<td>(17.63)</td>
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<td>(3.89)</td>
<td>(14.55)</td>
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<td>(11.15)</td>
<td>(6.46)</td>
<td>(5.09)</td>
<td>(4.27)</td>
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Note: All F-statistics indicate confidence levels above 99%.
Figure 7

Average Costs Per Case as a Linear Function of Bedsize*

*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 Percentage
E. Hospital Status, Caseflow Rate, Occupancy Percentage, Location in Boston
Figure 8

Average Costs Per Case as a Quadratic Function of Bedsize

*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 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.

\[ AC = 38.47 - 1.89 \times 10^{-3} \text{(BEDS)} + 1.49 \times 10^{-5} \text{(BEDS)}^2 \]

\[ R^2 = 0.04 \] (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

"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 approach 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 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 attractive, 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 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 proportion 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 particular 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:

"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


4. Ibid.

5. Ibid.


10. Refer to Footnote 8.


14. The other types of HMOs are called network group practices and independent practice associations.

15. This assumes that third parties reimburse hospitals after costs are incurred.


21. Refer to Footnote 18.

22. Based on this, studies of HMOs should consider both learning curve effects and life cycle of organizations being compared.


25. Ibid.


29. Most literature studies indicate that the marginal cost for an admission is greater than the marginal cost for a patient day.


40. Refer to Footnote 38.


43. Sanazais, P. and Williamson, J., "End-Results of Patient Cure," Medical Care, March-April 1968, pg. 128.
44. Medicaid was selected because of its reimbursement policy. Under its formula, Medicaid pays hospitals 70% of patient costs, and it was felt that this would give hospitals the incentive to contain costs in order to minimize their deficits.

45. Refer to Footnote 37.


47. Refer to Footnote 37.

48. Refer to Footnote 38.