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A statistical analysis of the cost of care in rural hospitals with policy implications
by Larry Evan Finch

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Applied Economics
Montana State University
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Abstract:

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The guidelines were established partly on the basis of the results of past empirical research which includes studies of strictly urban or urban and rural hospitals. No past studies have concentrated exclusively on rural hospitals. This study attempts to fill that gap in that only rural hospitals are examined and analyzed. It is hoped that the results of this study can be compared with the results of past efforts in order to determine if the policy implications suggested in the above guidelines are equally applicable to rural as well as urban hospitals.

In particular, this study attempts to estimate the extent to which savings can be realized through a program of consolidation in rural hospitals. The least-cost size and occupancy rate are estimated in order to determine the extent to which increasing occupancy rates and scale economies reduce average costs per patient day in rural hospitals. The savings that would arise from utilizing a system of hospitals of least-cost size operating at the least-cost occupancy rate are then estimated. The benefits that result can then be weighed by planners against the increase costs (ambulance service, risk, etc.) that arise as a consequence of consolidation in order to determine if the existing structure of rural health care delivery warrants change. The study also examines the relative costliness of services offered in rural hospitals and attempts to determine how costs vary among hospitals of different types.

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Date 6/12/80

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by

Larry Evan Finch

A thesis submitted in partial fulfillment
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of

MASTER OF SCIENCE

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Applied Economics

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Bozeman, Montana

May, 1980

ACKNOWLEDGEMENTS

Foremost, I wish to thank my thesis advisor, Dr. Jon Christianson for guiding me through this period of incipience and for offering me the opportunity to work in the field of health economics. Thanks, also, are due to John Marsh, (committee member), Oscar Burt (committee member), Douglas Young and Robert Chew for much needed help in regards to the statistical technique employed throughout the analysis. Finally, I would like to take this opportunity to thank the faculty, staff and graduate students of the Department of Agricultural Economics and Economics (1978-1980) for providing an ambiance most conducive to the completion of this thesis.

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ABSTRACT

The average cost per patient day of hospital care in the United States has risen more than 1,000 percent since 1950. This compares to an increase of 125 percent in the general level of consumer prices over the same period. This rapid rise in the cost of health care has focused legislative attention on the helath care delivery system and has prompted passage of the National Health Planning and Resource Development Act of 1974, which provides for health care planning by public sector agencies at the state and local level. In conjunction with the Act a set of National Guidelines, issued in August, 1977, recommend a maximum of four hospital beds per 1000 population and a minimum occupancy rate of eighty percent in hospitals in order to promote efficiency.

The guidelines were established partly on the basis of the results of past empirical research which includes studies of strictly urban or urban and rural hospitals. No past studies have concentrated exclusively on rural hospitals. This study attempts to fill that gap in that only rural hospitals are examined and analyzed. It is hoped that the results of this study can be compared with the results of past efforts in order to determine if the policy implications suggested in the above guidelines are equally applicable to rural as well as urban hospitals.

In particular, this study attempts to estimate the extent to which savings can be realized through a program of consolidation in rural hospitals. The least-cost size and occupancy rate are estimated in order to determine the extent to which increasing occupancy rates and scale economies reduce average costs per patient day in rural hospitals. The savings that would arise from utilizing a system of hospitals of least-cost size operating at the least-cost occupancy rate are then estimated. The benefits that result can then be weighed by planners against the increase costs (ambulance service, risk, etc.) that arise as a consequence of consolidation in order to determine if the existing structure of rural health care delivery warrants change. The study also examines the relative costliness of services offered in rural hospitals and attempts to determine how costs vary among hospitals of different types.

CHAPTER 1

INTRODUCTION AND BACKGROUND

Introduction and Objectives:

The average cost per patient day of hospital care in the United States rose from $15.62 in 1950 to $175.08 in 1976 [1]. This rise of more than 1,000 percent compares to an increase of 125 percent in the general level of consumer prices over the same period [2]. The sharp rise in the cost of hospital services has emphasized the importance of gaining a better understanding of the determinants of hospital costs. The purpose of this thesis is to investigate the determinants of costs in rural hospitals. Specifically, the major objectives of the research are:

1. To ascertain which of the services offered by rural hospitals are associated with high costs and which are associated with low costs.
2. To determine how costs vary among rural hospitals of different types.
3. To analyze the relationship between occupancy rates and the average cost of services in rural hospitals.
4. To investigate the presence or absence of economies or diseconomies of scale in small, rural hospitals.

In addition, the research will provide information on the differences in costs between public and private institutions and between for-profit and not-for-profit institutions.

This study is different from previous hospital cost studies in that it concentrates exclusively on rural hospitals. To further clarify the nature of the problem, the next section presents a brief history of the development of the rural hospital. Section III discusses some of the hypotheses explaining the rapid increase in hospital costs since 1950; and Section IV reviews recent regulatory and legislative efforts to contain or reduce costs.

Historical Development

The development of rural community hospitals has lagged behind that of larger, more urban institutions. Until about 1930 the development and financing of rural, community hospitals was largely dependent upon the initiative of the local populace. Rural, agricultural communities tended to be less affluent than urban districts, and usually found themselves lacking the necessary funds to finance the construction of hospital facilities. In the early 1930's only fourteen hospitals (funded by the Commonwealth Fund) were built in rural communities [3].

A further hindrance to the development of rural community hospitals during this period was uncertainty concerning the supply of qualified personnel to staff rural facilities. As a result of the Flexner Report, published in 1910, the number of certified medical schools fell from 162 in 1906 to 69 in 1944, severely curtailing the supply of licensed surgeons and physicians [4]. This reduction in supply was particularly hard felt in rural areas, which were viewed as relatively unattractive by medical practitioners. It was not until 1945 that the trend towards reducing the supply of manpower initiated by the Flexner Report was reversed.

During World War II a limited amount of federal funding for hospital construction was provided by the Community Facilities Act, but it wasn't until after the war that involvement on the part of the federal government in the construction of rural health services became significant. The National Hospital Survey and Construction (Hill-Burton) Act of 1946 provided grants to the states for the construction of government and voluntary non-profit facilities in those areas of "greatest need", which generally meant rural areas. The disparity in bed supply between rural and urban areas was largely eliminated within twenty years after passage of the Hill-Burton Act [5]. By 1966 over $2.5 billion of federal funds had been used to construct more than 350,000 additional hospital and nursing home beds, the bulk in rural areas [6].

The NHSCA did not provide for a coordinated system of comprehensive health planning and consequently much hospital construction since its passage has occurred in a rather haphazard manner. Communities may have been provided funding for the construction of facilities with little regard to the long-run appropriateness of the type of facility being built. This can be partly justified on the grounds that at the time transportation difficulties required each rural community to provide its own hospital services. With the development of the Federal Interstate Highway System and increased availability and use of air transport systems this problem became less important. Consequently, there has been a shift away from use of the local hospital to use of larger, urban hospitals, which are sometimes viewed as providing a higher quality of care. This has contributed to reductions in the traditionally low occupancy rates of rural hospitals, and low occupancy rates are one of several reasons cited for the current high cost of hospital services. The next section considers several of the more popular hypotheses regarding the rapid rise in the cost of these services over the past few decades.

Theories of Hospital Cost Inflation

In an article addressing the temporal changes in hospital costs, Karen Davis explains the reasons for hospital cost inflation and their importance for devising effective policy:

> ". . . If hospital inflation is largely a consequence of increasing demand without increases in supply, an expansion of hospital beds may be warranted. If the inflation is a labor cost-push inflation, attempts to curtail labor costs through wage guidelines or control may be the appropriate policy. If the inflation is induced by certain types of insurance coverage, a restructuring of insurance coverage

> may be called for. If the inflation is induced by inefficiencies in the hospital market, structural reform of the industry may be a desired course of action. If the inflation is the result of advances in medical technology, inflation may simply be a necessary price of improvement in health" [7].

In a similar fashion the President's Council on Wage and Price Stability is concerned about whether the persistent rise in hospital costs is attributable to one or more "one-shot" developments, or instead is explained by the basic structure of the industry. They note that the distinction

> ". . . is crucial to public policy formulation because a one-shot explanation could lead either to complaisance, if the cost driving phenomenon is viewed as behind us, or to a remedy geared to one particular aspect of the problem if the one-shot cause is viewed as ongoing. On the other hand, if the source of inflation is inherent in the basic structure of the hospital care industry, then nothing short of fundamental reforms or alteration of this structure will cause the inflationary pressure to abate" [8].

Theories of cost inflation are usually formulated in terms of "demand-pull" or "cost-push" inflation. There is evidence that both of these kinds of inflation may be operating in the hospital sector today.

On the demand-pull side it is clear that costs began to noticably rise after the introduction of Medicare in 1966 [9]. Prior to the passage of this piece of legislation medical services to the elderly were very costly. After retiring, many individuals, no longer entitled to the employee benefits of inexpensive group medical insurance (paid in part by their employers) and unable to afford the more expensive individual insurance policies, simply did not have the means of acquiring medical care. After the introduction of Medicare the cost of health services to these individuals was reduced considerably resulting in a substantially increased demand. In 1975 government payments accounted for about 44.5 percent of total hospital revenues [10].

Also applying pressure on the demand-pull side has been the development and increased use of commercial insurance. The year 1929 brought the initial development of general hospital insurance on a community basis with the introduction of Blue Cross. Ten years later state medical societies began to sponsor Blue Shield insurance. Then in the early 1940's private commercial insurance companies began to offer a variety of coverage programs to individuals. During the post World War II period, fringe benefits through collective bargaining and the growth of union-management health and welfare funds provided for a large expansion in the purchase of voluntary health insurance via group plans. This form of financing has grown from covering 29.3 percent of all hospital costs in 1950 to 43.6 percent in 1975 [11].

It has been argued that this tremendous increase in insurance coverage induces an increase in the demand for higher quality services and more lavish amenities, which generates higher costs [12]. It may be safe to conjecture, however, that the impact of insurance is not as strongly felt when considering rural hospitals exclusively. Rural workers are not enrolled as easily in an insurance program as are urban workers, who have access to large, employment-related, group plans. This means that rural residents more frequently purchase the more costly, and perhaps less comprehensive, single-buyer type of insurance policy or go without insurance. Therefore one might expect demand in rural areas to be less stimulated by the introduction of comprehensive insurance than was demand in urban areas.

On the cost-push side many analysts point to the large increase in hospital wages that has occurred in the post-Medicare period as a reason for hospital cost inflation [13]. They cite the development of stronger collective bargaining and the application of minimum wage legislation to hospital employees as the means by which wages have been "catching up". From 1962 to 1966 total hospital payroll expenses increased at an average annual rate of 10.1 percent; from 1966-1968 the annual increase was 16.4 percent [14]. Furthermore, increases in average earnings per employee account for 90 percent of the increase while increases in the number of employees per day of care accounts for the remaining 10 percent [15].

Recent studies, however, indicate that wage increases are not a direct cause of hospital cost inflation [16], that the threat of unionization is not significant in raising wages [17], that hospitals do not pass on increased profits in the form of higher wages [18], and that if hospital wages had risen only at the rate of all non-farm sectors during 1955 and 1975, the average hospital cost rate increase still would have risen at 8.8 percent per year rather than the actual 9.9 percent [19]. However, increases in the use and prices of non-labor inputs do seem to be important factors in explaining increased costs [20].

Two additional theories of cost inflation can be found in the literature. The first is that hospitals compete for status. The result of this competition is an unnecessary and inefficient duplication of facilities [21]. In instances where the facilities are not used to capacity, their cost is passed on to consumers in the form of higher hospital charges. This problem is reduced somewhat in rural hospitals due to the fact that they generally are isolated from direct competition within the community. However, it could be important for rival, rural communities in that the status of the hospital is visual evidence of the condition of the community. The second theory is that hospitals receiving remuneration under a cost-plus reimbursement scheme have a strong incentive to raise costs. Karen Davis has shown that under the assumption of either profit maximization or output maximization subject to a budget constraint, it is not advantageous for hospitals to raise costs under a cost-plus reimbursement scheme unless approximately 95 percent of the patients are covered by insurance that reimburses at a rate of 105 percent of cost [22]. Given that only about 88 percent of all hospital costs currently are covered by insurance, cost-plus reimbursement schemes would not appear to be significant contributors to increasing costs.

In summary, the evidence suggests that the basic structure of the hospital industry, characterized by third-party methods of payments and nonprofit firms, is responsible for rising hospital costs. The President's Council on Wage and Price Stability (January, 1977) concludes "... that unless cost control discipline is extended through an altered incentive structure, the spiral of inflation in this sector of the economy will continue [23]". An understanding of factors contributing to variations in cost among hospitals may provide a clue to understanding these temporal changes in cost. The next section discusses the regulation that has been implemented to combat the spiral of hospital costs witnessed over the last two decades.

Regulation

Much of the regulation and planning within the hospital industry has been focused on making hospitals more efficient. Early attempts to increase the efficiency of the health care industry through planning occurred with the passage of the Comprehensive Health Planning Program (CHP) of 1966. This program called for the creation of "A" agencies--

statewide health planning agencies--and "B" agencies--areawide health planning agencies staffed primarily by local citizens. The agencies were established to oversee general health care systems and devise comprehensive facilities planning at the "A" level; and to coordinate the flow of resources and deal with specific planning problems at the "B" level.

The program had little effect initially due to considerable ambiguity regarding the agencies' authority and responsibilities, and because staff members were typically inexperienced and unqualified. But as planners began to perceive their functions more clearly they requested more authority and received it in the form of certificate-of-need legislation, A-95 review and comment procedures, and Section 1122 review and approval.

Certificate-of-need legislation provided local planners with the authority to review proposals for the construction of new facilities. Although the agencies couldn't actually veto a project, their recommendations often carried considerable weight in the decision process of those agencies responsible for allowing or denying construction. A-95 review and comment procedures directed planners to voice their opinions on the validity of applications for federal funds. Section 1122 of the Social Security Amendment of 1972 gave authority to the planning councils to review all capital expenditures planned by health providers that a) exceeded $100,000, b) changed bed capacity, or c) resulted in substantial change in service in which federal reimbursements were anticipated for depreciation and interest. These additional responsibilities were not enough to keep the program from failing, however. The reasons cited for failure of CHP are lack of funding, lack of expertise, limited regulatory power and easy provider dominance [24].

The National Health Planning and Resources Development Act of 1974 [PL 93-641] is the major piece of planning legislation influencing the health care industry today. At the federal level the Act calls for the establishment of a new Bureau of Health Planning and Development within the Health Resources Administration of the Department of Health, Education and Welfare, the creation of a National Health Planning Advisory Council, and the location of ten regional Technical Assistance Centers. At the state level the Act mandates the establishment of State Health Planning and Development Agencies and Statewide Health Coordinating Councils. At the local level the Act establishes 213 Health System Agencies. Each HSA has no less than ten members, sixty percent of whom are not providers. Providers constitute the remaining forty percent of the governing body. In addition, the proportion of individuals from non-metropolitan areas must parallel the non-metropolitan proportion of the population in the health services area.

The functions, duties and responsibilities of HSA's are very much the same as those of the planning councils under the CHP program. Operating under federal funding and monitoring, they are charged with data collection and analysis, plan development and implementation, certificate-of-need review, and a periodic review of the "appropriateness" of institutional health services. Again, actual power is restricted in that the only yes/no authority over health institutions is the right to approve or disapprove of projects funded under the Public Health Services Act and related programs. These projects comprise roughly ten percent of federal health spending. One of the problems with CHP, the lack of a set of standards or "appropriateness" criteria, has to a considerable extent been overcome in that the NHPRDA called for the issuance of a set of national guidelines by the Secretary of HEW by mid-1976. Such a set of guidelines has been developed and disseminated [25]. Included are the specifications that there should be no more than four hospital beds per 1000 population in an area and that hospitals should operate at an 80 percent occupancy rate. Rural hospitals frequently have more than four beds per 1000 population and generally operate at much less than an 80 percent occupancy rate. The implication is that there is currently an excess capacity of hospital beds in rural areas. This excess capacity, generally viewed as inefficient, could subject existing institutions to an appropriateness review based on the benefits and costs of a program of consolidation.

It is hoped that this thesis will provide information to health planners, community leaders, HSA representatives, administrators and physicians that will enable them to devise a lower cost system of health care provision without incurring any loss in quantity or quality of services. To be more specific, the results of the research should shed light on which services offered by rural hospitals are costly and which are not costly, what the optimal hospital size and occupancy rate are for the sample being scrutinized, and which organizational forms tend to display lower costs.

CHAPTER 2

TRADITIONAL COST ANALYSIS AND THE HOSPITAL INDUSTRY - ANALYSIS AND LITERATURE REVIEW

Chapter 2 addresses some of the problems encountered in a cost analysis hospital, and some of the techniques used to overcome these problems. The chapter is divided into four sections. Section I is a review of traditional cost analysis under the assumption of profit-maximization for a firm utilizing one or more inputs to provide a single output in accordance with a specified production function. Section II extends the theory of Section I to encompass particular characteristics of the hospital industry. Section III discusses some of the problems encountered when doing cost analysis in the hospital sector and Section IV is a brief literature review of methodologies employed to solve the problems of Section III.

Traditional Cost Analysis

Traditional cost analysis begins with a discussion of the nature of the firm's production function. This is logical because, as will be shown, it is the firm's production function and the prices that the firm pays for inputs that determine the firm's cost function.

Production is defined as the process in which inputs are combined and/or transformed to provide some quantity of output. The production function is nothing more than the relationship between the quantity of inputs used and the quantity of output that can be obtained as a result. In other words, it provides us with a description of the current state of technology. For the single-output, two-input firm the production function may be expressed as

$$(1)\quad Y = f(X_1, X_2)$$

which often is expressed for convenience as

$$(2)\quad Y - f(X_1, X_2) = 0$$

or more simply

$$(3)\quad g\ (Y, X_1, X_2) = 0$$

For a firm such as a hospital that utilizes many different inputs to produce a variety of outputs the production function may be expressed as

$$(4)\quad g(Y_1, Y_2, \ldots Y_n; X_1, X_2, \ldots X_n) = 0$$

which simply states that varying proportions of the various inputs can be used to produce varying proportions of the various outputs.

Of importance to traditional cost analysis is the assumption of profit-maximizing behavior on the part of firms.* Although many contemporary authors have cited cases based on sound evidence that this is not always the firm's objective, the assumption provides an analysis that is at worst a close approximation of firm behavior and at best precisely the nature of a firm's operation. Although hospitals are not necessarily profit maximizing firms the following description of the production process is characteristic of hospitals as well.

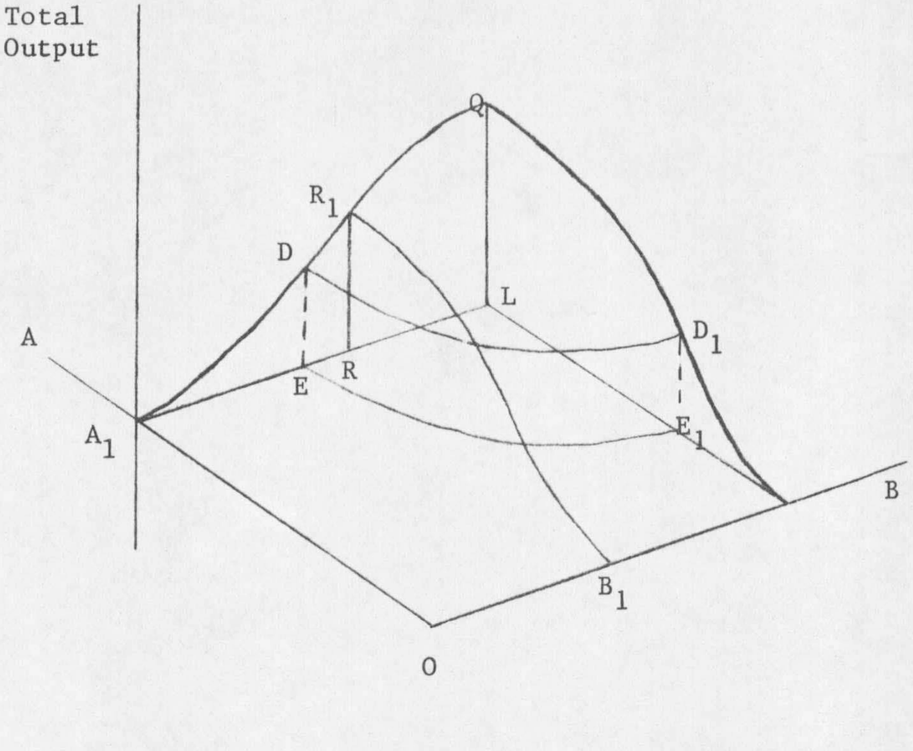
---

* Alternatively this may be stated as cost-minimizing behavior.

The nature of production for the single-output, two-input firm is illustrated in Figure 2-1. Here total output, a function of inputs A and B, is determined by the vertical distance from the plane OA_1LB to the production surface. For example, if quantity A_1 of input A is combined with quantity B_1 of input B, the resulting output would be measured by the distance RR_1. Figure 2-1 also shows how output varies with changes in one of the inputs while holding the other input constant. For example, the line B_1R_1 shows how output changes while holding the quantity of input B constant at B_1, and varying the quantity of input A from zero to A_1 units. Here the first few units of the variable input result in increases in output at an increasing rate, but eventually output begins to increase at a decreasing rate. This is due to the Law of Diminishing Marginal Returns which states that as further increments of a variable input are added to the production process, _other inputs held constant_, eventually output will increase at a decreasing rate. Although it can not be deduced from any physical or biological laws, empirical observation generally supports the intuitive appeal of this law.

A line of constant elevation on the production surface, such as line DD_1, projected down to the base plane results in a convex shaped

Figure 2-1. The Production Surface.


Total
Output
Q
R$_1$
D
L
A
D$_1$
E
R
E$_1$
A$_1$
B
B$_1$
O

curve (called an isoquant) like the curve in Figure 2-2. Isoquants are two-dimensional representations of the various combinations of two inputs that provide a constant amount of output. Figure 2-2 illustrates how the entrepreneur can use either a* units of input A and b* units of input B, or a_1 units of input A and b_1 units of input B to provide an equal amount of output.

The profit maximizing firm is interested in the lowest cost means of producing a given level of output. This is determined with the aid of the downward sloping straight lines in Figure 2-2 which are called isocost lines. Isocost lines are lines showing all the possible combinations of inputs that could be utilized for a given level of cost. The slope of the lines is determined by the ratio of the prices of input A and input B. More precisely the slope is equal to $- P_A/P_B$. The lowest cost quantities of each input to be used in the production of a desired output level are determined by the point of tangency of the isoquant with the appropriate isocost line. This is point R in Figure 2-2. The least cost combination of A and B is a* and b*. Note that the same amount of output could be produced by using the quantities a_1 and b_1 of inputs A and B. This would be an inefficient process, however, because point S lies on a higher level isocost line than point R, and at point R the same amount of output can be produced at a lower cost.[†]

[†] Note that the dual to this problem is to determine the level of output that could be obtained given a specific level of cost. In this case the solution is to pick the isoquant that lies just tangent to the given isocost line.