Cost-benefit analysis and health care planning : an application to rural hospital closures
by Steven Glenn Bender

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

Abstract:
The purpose of this thesis is to apply cost-benefit techniques to evaluate rural hospital closures. Data on hypothetical closures are examined to illustrate the relative importance of various types of benefits and costs. The distribution of benefits and costs that explain community support for hospitals is identified as an aid for public decision makers. The first chapter provides background and rationale for the research. The second and third chapters develop frameworks for evaluation closures. The fourth chapter presents the application of the framework to four hypothetical closures. The policy significance of the empirical results is discussed in the concluding chapter.

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Date July 31, 1980

DEDICATION

This thesis is dedicated to my wife,

Cindy Bender.

COST-BENEFIT ANALYSIS AND HEALTH CARE PLANNING:

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by

STEVEN GLENN BENDER

A thesis submitted in partial fulfillment
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My parents are deserving of special attention for their support. guidance and encouragement.

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ABSTRACT

The purpose of this thesis is to apply cost-benefit techniques to evaluate rural hospital closures. Data on hypothetical closures are examined to illustrate the relative importance of various types of benefits and costs. The distribution of benefits and costs that explain community support for hospitals is identified as an aid for public decision makers. The first chapter provides background and rationale for the research. The second and third chapters develop frameworks for evaluation closures. The fourth chapter presents the application of the framework to four hypothetical closures. The policy significance of the empirical results is discussed in the concluding chapter.

Chapter 1

PURPOSE OF STUDY

The purpose of this study is to apply benefit-cost techniques to evaluate rural hospital closures. Data on hypothetical closures will be examined to illustrate the relative importance of various types of benefits and costs. The distribution of benefits and costs that explain community support for hospitals will be identified as an aid for public decisionmakers.

The purpose of this chapter is to define the problems faced by rural hospitals that contribute to closures. The second chapter develops a formal framework for assessing hospital closures. The next chapter discusses the simplifying assumptions necessary to make an assessment of benefits and costs practical. This model, with its simplifying assumptions, is applied to four hypothetical cases in Chapter 4. The policy implications and a summary of the theoretical and empirical results are in the concluding chapter.

BACKGROUND

Hospital cost inflation is a problem receiving much attention in the United States. The hospital price index increased 352 percent from 1960 to 1974, compared with a 167 percent increase in the consumer price index for the same period. Hospital expenditures increased by 500 percent per capita during this same period. Not only is the absolute size of expenditures for hospital care growing, but the total of all health care expenditures as a proportion of gross national product (GNP) also is increasing. Between 1960 and 1974, the health care industry's proportion of GNP rose from 5.3 percent to 8.0 percent making health care industry the third largest in the United States.

Possible reasons for the rapid increase in hospital costs are abundant. Low occupancy rates indicating excess capacity is a major contributing factor. Excess capacity has been defined by McClure as "any hospital capacity which contributes unnecessarily to per capita health care expenditures, if alternative, less expensive medical (or non-medical) means exist to achieve equal levels of health" (McClure, p. 15). Under-utilized hospital capacity results from "capacity built, equipped and/or staffed to handle a volume of services in excess of its actual utilization" (McClure, p. 12). A rural hospital over-built for community needs would fall into this category. McClure (McClure, p. 12) argues that excess capacity may be in evidence even though the occupancy rate is high. That would be the case when less intensive alternative services than now being provided would have sufficed for adequate inpatient care.

Excess hospital capacity contributes to higher than necessary health care costs. Hospital costs are high since fixed costs of providing care are spread over relatively few patients. A more subtle effect of excess capacity on hospital cost is the "Roemer effect," which states that empty beds induce utilization (Roemer, May). In this case, individuals are hospitalized when less intensive treatment would have sufficed.

Studies indicate that 5 to 10 percent of the licensed acute care beds are under-utilized (McClure, p. 19). Bennett and Sattler estimated a total of 68,887 under-utilized beds existed in 1975. This translates to 7.5 percent of the bed stock at that time, even allowing for different ideal occupancy rates for small hospitals (Bennett and Sattler cited in McClure, p. 70). The Bureau of Health Planning (HEW) estimated a gross surplus (corrected for under-supplied areas) of 83,217 beds for the same period (HEW cited in McClure, p. 19).

The Federal government has set guidelines for bed supply and utilization for the nation in an attempt to identify areas of excess capacity. The guidelines call for a maximum of four beds per 1000 population with an occupancy rate of 80 percent for short-term hospitals. This guideline compares with a supply of 4.5 beds per 1000 population and an average occupancy rate of approximately 76 percent in the nation in 1978.

A new planning and regulatory structure to implement these guidelines created 213 Health System Agencies (HSA's). HSA's are designed to work with existing state planning agencies to provide for public accountability and control of the local medical systems. They are private, non-profit organizations consisting of professional staff, providers and consumers (Altman, p. 562). Each HSA is required to "review on a periodic basis, but at least every five years, all institutional health services offered in its health service area and make recommendations to the state agency . . . respecting the appropriateness in the area of such services" (Federal Register, p. 71769).

The HSA review process is concerned with existing institutional health services, with a goal of identifying areas or institutions with excess duplication of services (and areas with unmet needs). Health services that fall under the appropriateness review process include those provided through private and public hospitals, rehabilitation facilities, and nursing homes. Low occupancy hospitals will receive considerable attention because their occupancy rates are assumed to indicate excessive duplication and inefficiency in the delivery of hospital services. Furthermore, institution-specific findings are viewed as the most effective means of eliminating excess capacity (Federal Register, p. 71768). At the present, the health planning structure lacks an enforcement mechanism for institutions that are viewed to be inappropriate.

> The Committee (Committee on Interstate and Foreign Commerce) has not required any sanction related to these reviews which would require that unneeded existing institutional health services be eliminated or closed. However, were a state to decide on its own initiative to create such a sanction, the Committee would of course have no objection to this. (Federal Register, p. 71754.)

While HSA's currently have no formal regulatory authority, a facility specific finding of inappropriateness would require a recommendation for remedial action. It also would attach a stigma to the facility, making it difficult for the hospital to attract staff and financing. Thus, HSAs have considerable de facto power to affect the closure of health care institutions through the appropriateness review mechanism.

Many rural hospitals would be subject to close scrutiny under a strict interpretation and enforcement of the guidelines. Rural hospitals are typically small and have relatively low occupancy rates (Michela, p. 1; Raatke and Nordblom, p. 1). These low occupancy rates suggest that some hospitals may come under pressure to close in order to bring the remaining facilities within the suggested guidelines.

The closure of rural hospitals is likely to be controversial and opposed by residents of rural areas. Hospitals in rural areas are a major source of employment, physicians and administrators are usually key community figures, and hospitals are monuments to civic pride (Altman, p. 575). Hospitals are also seen as a means to attract physicians to rural communities. The importance of rural hospitals to their communities is illustrated by the sheer volume of letters received by HEW in response to the Federal guidelines. Over 55,000 comments were received and about 80 percent of these were from persons who apparently lived in small towns and rural areas (Zwick, p. 412).

Health care planners will have to make decisions that alter the allocation of health care resources in the appropriateness review process. Cost-benefit analysis provides one framework for judging the appropriateness of a hospital. The application of this framework provides information that can guide what is essentially a political decision. Gainers and losers of a proposed closure can be identified in a benefit-cost framework and the magnitude of these effects calculated. Thus, the distribution of the resultant benefits and costs can be used to generate an understanding of the politics of rural hospitals.

Chapter 2

A COST-BENEFIT FRAMEWORK FOR EVALUATING RURAL HOSPITAL CLOSURES

General Introduction to Cost-Benefit Analysis

Cost-benefit analyses are used to evaluate public policy decisions concerning alternative use of resources. It is a systematic method of comparing the benefits and costs of alternative policies. Decisionmaking is aided because dollar values are assigned to alternative outcomes and these values identify the relevent policy issues.

Allocative efficiency is the explicit concern of cost-benefit analysis, but those who lose also can be identified. Haveman and Weisbrod (Haveman and Weisbrod, p. 39) define efficiency as follows:

> Allocative efficiency as an economic goal reflects the fact it is sometimes possible to reallocate resources in ways which will bring about an increase in net value of output produced by those resources.

A policy is desirable by the efficiency criterion if the aggregate dollar value of the gains of a project out-weigh the dollar value of the losses. Changes in the aggregate welfare of people are estimated by assigning dollar values to the aggregate gains and losses.[1]

The distribution of benefits and costs is ignored by the allocative efficiency goal. A project may yield large benefits, but the gains and losses may be distributed very unequally. Thus, the distributional impacts contain important information for many studies even though it is not the direct concern of allocative efficiency.

The efficiency goal may be sacrificed in public policy decisions because of income distribution consequences.

Direct benefits of a policy or project have been defined as "an increased value of the output associated with a project" (Sassone and Schaffer, p. 37) or "additions to the real product of an economy" (Sassone and Schaffer, p. 32). Direct benefits can arise from greater physical production, changes in quality of a good or service, changes in spatial value, or changes in temporal value (Sassone and Schaffer, p. 37). The value of benefits is measured by willingness of consumers to pay for the outputs of the project. This in turn depends on consumer demand for the product.

The willingness to pay for a good is illustrated graphically in Figure 2-1. The demand curve, D_1, is the quantities of a good that

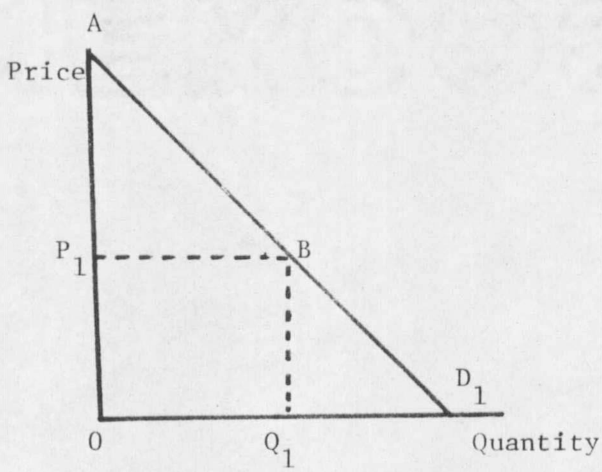


Figure 2-1. Demand for Good X

will be purchased at each price. At a price of P_1, the quantity Q_1 will be purchased. The price P_1 is the willingness of consumers to pay for the additional unit Q_1. The total amount payed for all units, OQ_1 is the area under the demand curve OQ_1 B P_1. However, consumers would have been willing to have paid a total of OQ_1 B A for OQ_1 quantity.[2] This is the gross value of OQ_1 units of good X. Thus, consumers would have been willing to pay more for the good than they actually spent.

Indirect benefits "reflect the impact of the project on the rest of the economy" (Eckstein, p. 202). For example, an irrigation project may increase tractor sales and the income of implement dealers. Economic multipliers have been used to estimate these induced benefits. The indirect benefits included in a cost-benefit analysis depends upon the analyst's assumptions concerning the scope of the analysis and the nature of the economy. If labor is perfectly mobile and fully employed, wage income is not included in national benefits. The labor used by the project will be drawn from other areas and the gains to one area are cancelled by losses to another. On the other hand, "if the objective of the project is regional development, or spatial redistribution of economic activity, then these indirect labor benefits may be real and important and should at least be identified" (Sassone and Schaffer, p. 40).

Costs are the value of the resources used by the project. Whatever the ultimate nature of the costs in question, they should be valued at the opportunity cost of resources used by the project. Opportunity cost is the value foregone by the use of the resources. For example, society losses what workers would have produced at their previous employments. The workers' wages are an estimate of what is lost to society. This logic can be extended to all the resources used in the project.

The opportunity cost of resources is the marginal cost of those resources. Marginal cost is the cost of an additional unit of output and indicates the next best use of a resource. The area under a marginal cost curve is the opportunity cost of the resources employed.[3]

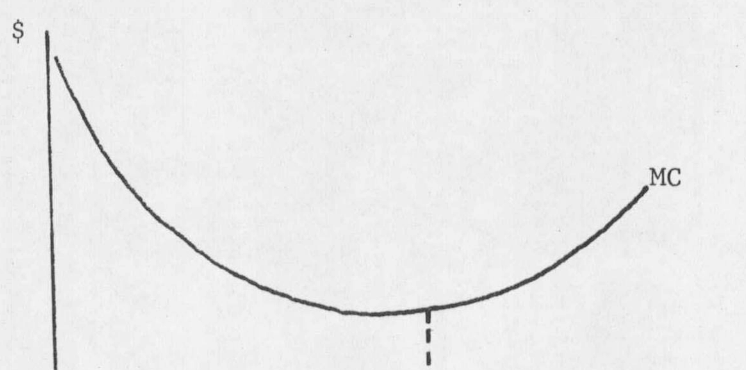


Figure 2-2.

Marginal cost curves are typically assumed to be U-shaped, as illustrated in Figure 2-2. At low output levels (less than X) the additional cost of producing an additional unit falls due to more efficient use of the resources employed. For example, the first unit of output provided by a hospital will be expensive since the hospital will have to hire some staff. As more units of output are provided, more efficient use is made of the available staff. As output is continually expanded, a point is reached where the marginal cost begins to increase at an increasing rate. As output is increased beyond point X, additional staff (and other resources) must be employed which increases the marginal cost of producing the additional units of output.

Benefits and costs of most projects accrue over time. Discounting is used to take this time stream of benefits and costs and their sequencing into account. In discounting benefits and costs, the following formula is appropriate:

$$NPV = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t}$$

where NPV is the net present value of the project (or policy), t is the time period, T is the life of the project, and r is the interest or discount rate. The term $1/(1+r)^t$ weights the net benefit estimates to take into account their temporal distribution with future years receiving lower weights. Benefits (B) and costs (C) are calculated for each year and discounted to the initial time period (t=0). For example, suppose a project results in net benefits (B-C) of -10, 10, and 30 for the three year life of the project. Further assume the discount rate is five percent. The net present value of this hypothetical project is:

$$NPV = \frac{-10}{(1+.05)^0} + \frac{10}{(1+.05)^1} + \frac{30}{(1+.05)^2} = \$26.88$$

Note that the net present value is less than the addition of the non-discounted net benefits due to the weighting of future benefits. The results of this hypothetical example indicate the project would be desirable to undertake because the net present value is greater than zero.

The discount rate reflects society's time preference and the rate of return on the resources in alternative uses.[4] Determination of a discount rate to fulfill either of these requirements is difficult and subject to debate. Most cost-benefit studies present outcomes for a range of discount rates, leaving the decision of which is appropriate to the decisionmakers.

Net present value estimates are sensitive to the discount rate. In the previous example of the discounting formula, a five percent discount rate yielded a net present value estimate of $26.88. A rate of 10 percent results in a net present value of $23.88. Comparing the two calculations indicates that the net present value falls by $3 due to the use of the higher discount rate. This decrease would have been more profound if the time span were longer because the weight decreases as higher discount rates are used. Low discount rates give more weight to the future stream of net benefits. Therefore, the use of low discount rates tends to make the project appear more desirable if costs are concentrated in the initial years and benefits in the latter years of a projects life. The converse is true for high discount rates.

Generally, there is a spatial distribution of benefits and costs associated with a project. The geographic area to be studied defines the relevent benefits and costs. For example, if the area is initially assumed to be a given community, many benefits and costs will be external to the community and the inclusion of these external effects is unwarranted. When the accounting stance is broadened to a larger area, the new scope would contain some of the effects previously excluded.

ALTERNATIVE COST-BENEFIT FRAMEWORKS FOR EVALUATING CLOSURES

Cost-benefit analysis can be applied in a planning context, or it can be used in a more complete economic framework. The "planning approach" applied to medical services ignores the role of price in determining the quantity of medical services consumed. The planning approach assumes the use of hospital services is a function of the number of individuals and their characteristics. Economic theory suggests this formulation is not entirely correct. The "economic approach" recognizes that the quantity of medical services consumed is responsive to price. Research suggests the non-profit hospitals follow an average cost pricing scheme (Newhouse, p. 65). Furthermore, the average cost of providing hospital services declines as utilization increases (Finch and Christianson, p. 28). This research implies that the price of medical services will fall if a neighboring hospital closes. An evaluation of hospital systems must consider both responsiveness to price and changes in costs of services.

The "Planning Approach": A Cost-Benefit Framework

The planning approach of cost-benefit analysis is used to investigate the effects of a closure of a rural hospital. The objective is to evaluate the operation of two hospitals compared with that of only one.

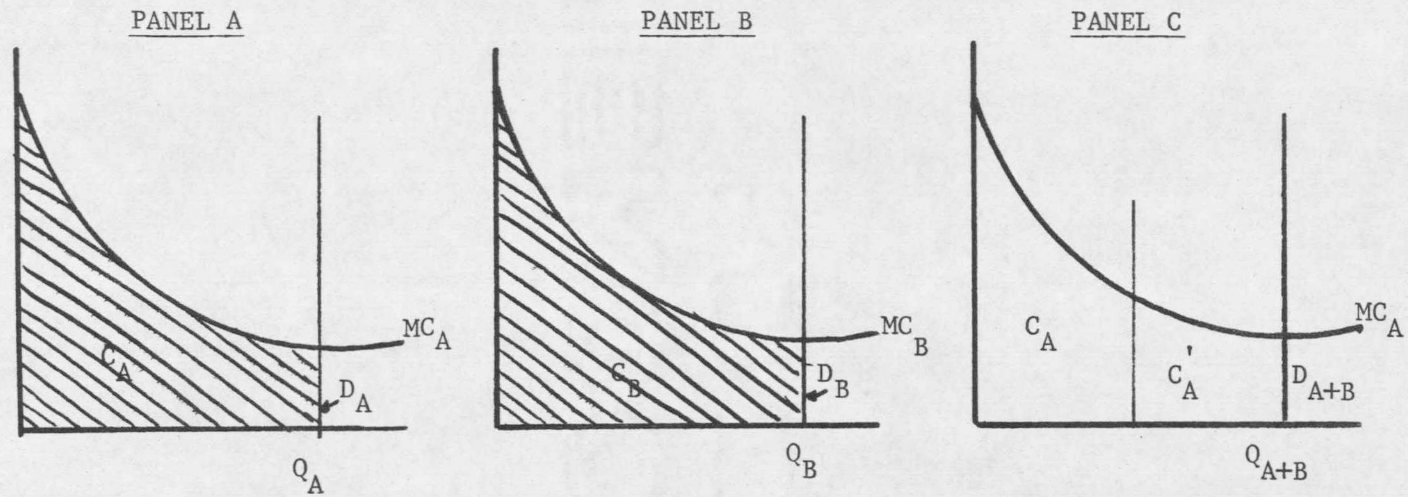
Health care planners and hospital planners base their decisions on the population of the area under investigation. Average utilization statistics for different services in conjunction with demographic information establish the type of services and the service levels "needed" by the area's residents. The number of patient days needed in an area is a function of the size of the hospital service area. The number of beds needed depends upon the occupancy rate assumed. Cost-effective means of providing services then can be estimated once the area's need is established. Whether to use one or two hospitals to provide the estimated patient days can depend on cost.

The planning approach assumes 1) the same quantity of services are needed regardless of the number of facilities, and 2) the services provided by the two alternative systems will be identical. Furthermore, it is assumed that individuals in Community A use the facility in their community and that Community B use their facility.[5] All the individuals are assumed to attend Hospital A if it is the only facility in the area.

The evaluation of a closure using the planning approach is illustrated in figure 2-3. The quantity services "needed" by each community is Q_A and Q_B in figure 2-3. The quantity of services needed in the total area is Q_{A+B}. The demand for each facility is represented by D_A, D_B, and D_{A+B}. The marginal cost of providing services are represented by MC_A and MC_B. Panel C assumes that Hospital A remains open and services the former patients of Hospital B which is closed.

The closure of Hospital B will result in net benefits of $(B_1-C_1) - (B_2-C_2)$, where the subscripts 1 and 2 represent each case. The net benefits resulting from the operation of only Hospital A are (B_1-C_1). The net benefits of operating both Hospitals A and B are (B_2-C_2). System 1 and system 2 provide the same gross benefits in this formulation.

Benefits are measured by the total willingness to pay and are estimated by the area under the demand curves. Since the same quantity of services are provided in either case, the total willingness to



Panel A -
Community A's demand for services in Community A.

Panel B -
Community B's demand for services in Community B.

Panel C -
Total area demand for services in Community A.

Figure 2-3.

pay estimates are equal[6] and cancel each other out ($B_1 = B_2$). The gross benefits resulting from one hospital are infinite, given the tacit planning assumptions of vertical demand curves, as are the gross benefits resulting from the operation of two hospitals. Therefore, net benefits resulting from the closure of Hospital B are determined by the differences in the social costs ($C_2 - C_1$) of providing the desired quantity of services under the two different systems.

The net benefits of the closure of Hospital B is the difference between the cost of providing services by the two systems. The opportunity costs of the resources employed by Hospitals A and B are compared with the opportunity cost of the resources that would be employed by Hospital A upon the closure of Hospital B. The areas under the respective curves in Figure 2-3 are the opportunity costs of the resources. Panels A and B represent the two-hospital system and Panel C represents the continuation of only Hospital A. The opportunity cost of the resources employed by Hospital A to produce the community's hospital care needs is the area under MC_A evaluated at Q_A. The area under MC_B to Q_B is the opportunity cost of the resources employed by Hospital B. Addition of these two estimates yields C_2, the social costs of providing care with two hospitals.

The opportunity cost of the resources employed by Hospital A to produce the desired service level when Hospital B is closed is C_1.

C_1 is provided by the area under MC_A in Panel C up to Q_{A+B} or $C_A + C_A'$. With these estimates in hand, a first-round estimate of the net benefits resulting from the closure of Hospital B can be obtained. The cost of operating two hospitals to provide the needed services (C_2) is the simple addition of the cost of each facility. Therefore, C_2 equals C_A plus C_B. Net benefits resulting from the closure of Hospital B are estimated by $C_2 - C_1$.

$$\begin{aligned} \text{NB closure} &= C_2 - C_1 \\ &= C_A + C_B - C_A - C_A' \\ &= C_B - C_A' \end{aligned}$$

The net benefits of the closure are positive if C_B is greater than C_A'. In other words, more resources are employed by Hospital B than would be used if Hospital A were to expand its output to provide the services of Hospital B.

The first-round approximation of net benefits is the resource savings of the hospital system resulting from a closure. However, the closure would impose additional costs on society that are external to the hospitals and not captured in the first-round approximation. Individuals from Community B will have to travel to consume hospital care after the closure. The individuals and their visitors will expend resources in the process and an estimate of the value of the resources consumed by travel should be used to correct the first-round net benefit estimate.

Greater travel time inherent with the closure of Hospital B will result in another cost that is borne by Community B (assuming universal risk aversion). This is the cost of the increased risk or increased probability of mortality and morbidity assumed by Community B. Time can be crucial in some accident and other general emergency cases. For some routine care, the increased travel time will have a relatively insignificant effect on this risk.

Mishan provides a useful guide on the quantification of increases in risk. Risk can be broken down into four different types: 1) voluntarily assumed risk, 2) direct involuntary risk, 3) indirect or derivative risk, and 4) psychic risk (Mishan, pp. 310-315). Voluntarily assumed risk does not present a problem since it is reflected in the demand for a product consumed. Direct involuntary risk is imposed on individuals as a result of a public policy. An example would be the involuntary closing of Hospital B which forces Community B to assume increased risk. Derivative or indirect risk would arise from the financial aspect associated with the death of a family member or employee. Finally, psychic risk involves concern by others for individuals who are placed in a more risky situation. For example, parents of individuals in Community B may worry about the effects of the closure of Hospital B on their sons and daughters. Ideally, all of these components of risk should be measured and included in the analysis. Indirect and physic risks can not be quantified. Voluntarily assumed risks are reflected in prices. Thus, direct involuntary risks are the only type remaining.

The concept of involuntarily assumed risk is illustrated by an individual who chooses among risky alternatives. Casual observation and empirical research indicate that people possess indifference curves for risk and money (Thalor and Rosen, Mishan, Acton, 1976). Suppose the individual has an indifference map for risk and money as shown in Figure 2-4. The shape of the indifference curve indicates that as the risk of death increases, the individual requires greater compensation for assuming the risk. The logic can be reversed to determine the willingness to pay to avoid risk. Figure 2-4 also illustrates that a sum of money does not exist that would compensate the individual for certain death. On the other hand, people are not willing to pay the large amounts of money that probably would be necessary to avoid all risk.

An individual's willingness to pay to avoid risk can theoretically be measured from the indifference curve. For example, suppose the individual's subjective risk of death was increased from the probability of X to Y. Given the shape of the curve, one can conclude the individual would pay $Y' - X'$ to avoid this risk.

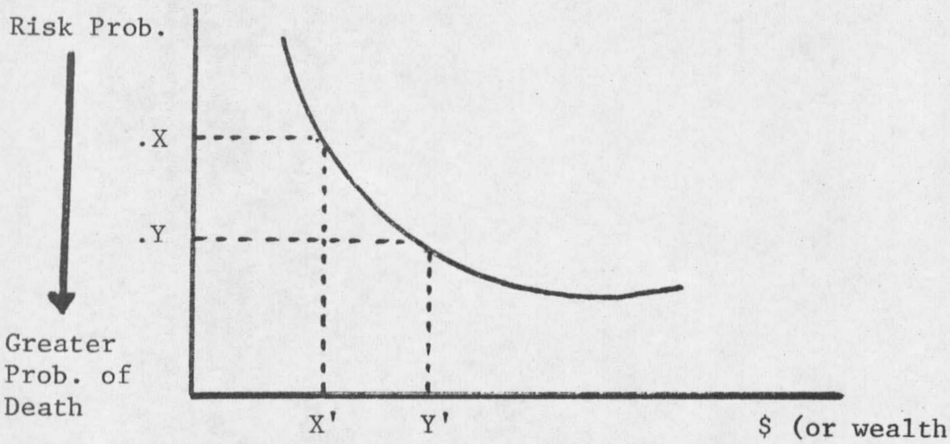


Figure 2-4.

The estimation of the cost of risk is, at best, on shaky ground given the present state of the art. Approaches used to place a value on loss of life, such as the discounted present value of production lost, discounted value of net output, and life insurance are all unsatisfactory.[7] The method presented is the only theoretically consistent method (Mishan). Application of this method rests on individual preferences to determine the shape of the indifference curve and the subjective probabilities. Even if the method can be successfully applied, it measures the willingness to pay to avoid direct involuntary risk. The remaining two components, indirect or derivative risk and psychic risk, are not quantified and possibly could be substantial.

Explicit estimation of this area of costs will not be attempted. However, the possible costs associated with increased risk will not be totally ignored. Net benefit estimates of a closure (exclusive of the costs imposed by risk) can provide an estimate of what the willingness to pay to avoid risk would have to be for net benefits to equal zero. For example, suppose that net benefits from a hospital closure are calculated to be $5,000, ignoring risk. In this case, the willingness to pay to avoid the risk would have to be at least $5,000 to make the closure undesirable. More information can be provided by the net benefit estimate ignoring risk. Risk can be reduced by devoting resources to more and better equipped ambulances. Increasing the number of ambulances can decrease the response time which essentially would decrease the probability of death and the degree of pain and suffering for rural patients. Better equipped ambulances can provide patient monitoring, oxygen and other services which would help stabilize the patient in transit to a hospital. The dollar value of these increased resources can be obtained and then compared with the net benefit estimate ignoring risk to investigate whether net benefits are large enough so that Community B could be compensated for the increased risk by the purchase of additional ambulance services.

Health care planning uses the assumptions which have been discussed. A cost-benefit framework can be formulated to be consistant with these assumptions. The framework involves estimating the cost savings that would accrue from a one hospital versus a two hospital system. Additional costs of a closure involve travel and risk costs imposed on individuals in Community B. Quantification techniques will be suggested for valuing these additional costs.

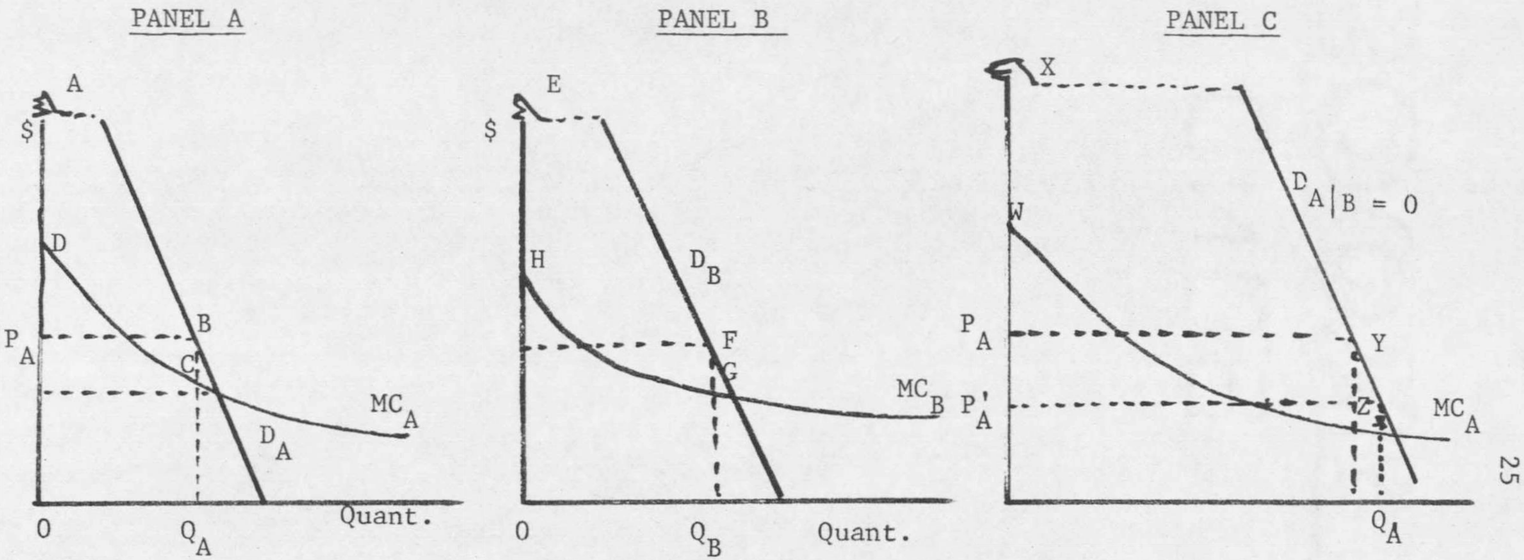
The "Economic Approach": A Cost-Benefit Framework

The economic approach to the application of cost-benefit analysis to hospital closures assumes that the quantity of medical services consumed is responsive to price and that the price should decline in the remaining hospital due to the closure. There is no reason to assume that the quantity of hospital services provided after the closure will equal the quantity provided by the two hospitals combined. The gross benefits of the different hospital systems must be considered in the economic approach because of these considerations.

The gross benefits of hospital services are dependent on the quantity of services consumed which in turn is a function of the price of the services. Insurance is an important determinate of the price of hospital services. People with insurance pay only a fraction of the administered price for hospital services (Pauley, p. 535, Feldstein, p. 854). Two individuals with identical demands may consume different amounts of hospital services because of insurance. Assume that one individual (X) has no insurance and the other (Y) is completely insured. The direct price to individual X per unit of hospital service is the administered hospital price. The hospital price to individual Y may be zero due to insurance coverage. The insurance premium is a constant amount regardless of the number and types of illnesses. Under these conditions, individual X will consume fewer services than individual Y. Therefore, the aggregate quantity of medical services consumed will be a function of the administered price of the service and insurance coverage.

The economic approach suggests each community's demand for hospital services should be somewhat responsive to prices and that the price should fall in Hospital A after the closure of Hospital B. Assume all this information is known and can be presented graphically, as in Figure 2-5. In Figure 2-5, D_A, D_B, and $D_{A/B = 0}$ represent the demand curves for care in Community A, Community B, and Community A after the closure of Hospital B, respectively. The curves labeled MC_A and MC_B represent the marginal cost of providing services in each community. P_A and P_B represent the average price paid by consumers and reflects the insurance coverage of the communities. P'_A represents the new price to all area consumers after the closure of Hospital B.

The quantification of net benefits resulting from the closure of Hospital B in this formulation is similar to the approach used in the preceeding discussion. The fundamental difference is that gross benefits must be taken into account. There is no reason to assume they cancel in this formulation. Therefore the net benefits resulting from the provision of services in two communities are equal to each community's willingness to pay for the services minus the opportunity



Panel A
Community A's
demand for services
in Community A.

Panel B
Community B's
demand for services
in Community B.

Panel C
Total area's demand
for services in
Community A.

Figure 2-5.

cost of the resources used to provide the services. After the closure of Hospital B, the net benefits that accrue through the provision of services in Community A is a comparison of the total area's willingness to pay for these services and the opportunity cost of the resources. The net benefits from the provision of services in Community A, given that Community B is providing services, are estimated by the willingness to pay for these services (ABQ_AD in Panel A of Figure 2-5) minus the cost of providing those services (DCQ_AO), that is, net benefits equal to ABCD. Similarly, the net benefits of providing services in Community B are estimated by EFGH in Panel B. The net benefits of services in Community A after the closure of Hospital B are estimated by XYZW. To determine the net benefits of closing Hospital B, the net benefits that occur under the two hospital system must be subtracted from the net benefits when only Hospital A is in operation. This estimate is XYZW - (ABCD + EFGH). Travel costs and risk costs resulting from the closure of Hospital B should be included in the estimate of the net benefits of a closure. After this modification net benefits equal to $(XYZW - TC_B - R_B) - (ABCD + EFGH)$ where TC_B and R_B equal the travel cost and risk cost estimates.

The calculation of net benefits can be altered somewhat if insurance reduces the price of services to the community below $\overline{P}$ in Figure 2-6. In the previous discussion, the price to consumers was

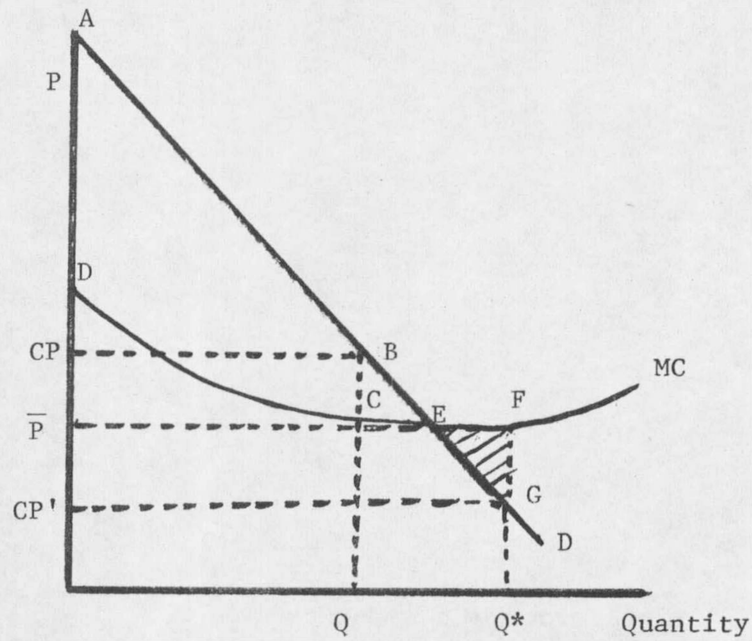
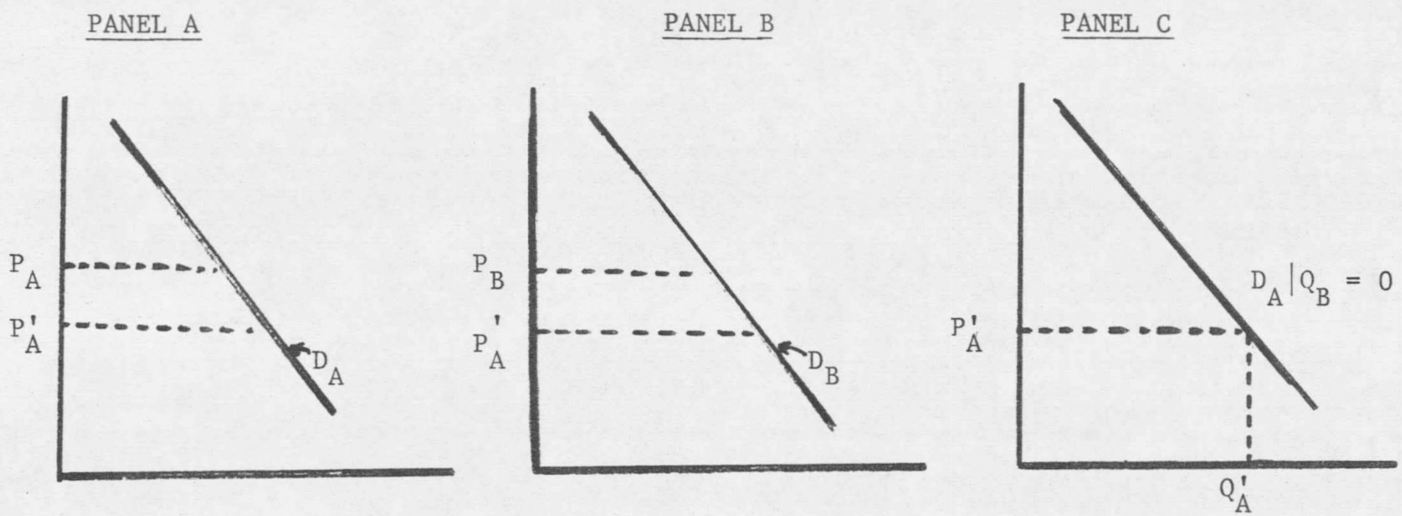


Figure 2-6. Net Benefits Under Differing Degrees of Insurance Coverage.

assumed to be CP and net benefits were estimated by ABCD. Suppose that insurance reduces the price to CP'. In this case, gross benefits are estimated by AGQ*O and the opportunity cost of the resources used to produce the Q* services is estimated by DEFG. Therefore, net benefits are approximated by AED - EFG (Pauly, p. 534). The additional costs of producing the marginal units exceeds the additional benefits from their consumption and EFG must be included.

This economic approach also identifies gainers and losers from the closure of Hospital B as in Figure 2-7. Individuals in Community A benefit unambiguously due to the price reduction in Hospital A.[8] The



Community A's demand for services in Community A

Community B's demand for services in Community B

Total area's demand for services in Community A

Figure 2-7.

price of services decreased from P_A to P'_A in Panel A leading to an increase in consumer surplus equal to the shaded area. If the price reduction is greater than the risk and travel costs (if $P_B - P'_A$ is greater than TC + R), then people in Community B will benefit from the closure. If risk and travel costs exceed the price decrease, then these individuals lose as a result of the closure. The outcome will depend on empirical évidence.

The economic approach provides a realistic picture of the net benefits resulting from a hospital closure. Due to the generality of the economic approach, it will be used to estimate net benefits. In the concluding chapter the results of the two different formulations will be compared.

Potential Modifications

Demand functions were proposed as tools for estimating the willingness to pay for a given quantity of hospital services. Biased estimates of willingness to pay may be obtained if the demand curves do not represent the demand of well-informed consumers. A fully informed individual would have as much information on the procedure's costs and consequences as is available. However, many consumers do not fully understand the consequences of their illness or the outcome of the prescribed treatment. Furthermore, medical services are not repeated purchases as are many consumption goods and the ability to learn from experience is reduced, as are the gains from obtaining the information.[9] The observed demand will be influenced by physicians' preferences resulting in an overestimate of the consumers willingness to pay.

The use of marginal cost to estimate the social cost of providing medical services can produce a biased estimate. Marginal cost was used to approximate the opportunity cost of the resources used to produce the hospital services. First, marginal cost may differ from social cost because hospitals are not profit maximizers. This implies resources may be combined in an efficient manner. The value of the contribution to the final product of the resources may differ from the price paid for those resources. Furthermore, the connection between marginal cost and social cost rests on the assumption that input markets function perfectly. This assumption may break down in rural economies. The resources used to produce hospital services may not have their next best alternative within the community and may be inmobile. Additional costs will be imposed on society. For example, suppose a nurse is unemployed by the closure of Hospital B. Costs are not imposed on society if the nurse is reemployed at the same wage. The closure will result in a direct loss of income to Community B if the workers are not reemployed at equal wages in that community. Specialized labor, such as the hospital's professional staff, may be reemployed at a lower wage or may move. This direct loss of income would result in indirect income losses to retail establishments and service industries. Net benefits estimated at the community level would have to be corrected to include these costs. However, there would be a redistribution of economic activity from Community B to other areas assuming that workers are reemployed in other health care facilities. The use of a broad accounting stance implies the gain of other areas will cancel to loss to Community B.

Community B could suffer an income decline even if all the freed workers are reemployed within the community. Patients and visitors would no longer be spending money within the community and businesses would suffer income decline. In general, the closure of Hospital B would decrease the long-run viability of the community. Extension of the accounting stance would capture the cancelling income gains to other areas. For example, Community A would experience increased incomes due to the transfer of spending from Community B, which cancel at least partially this component of lost income.

Thus far the hospital building has been ignored. Obviously, when Hospital B is closed the building would no longer be used for a hospital. The cost of the building is not a relevant concern.

> Non-relevant costs are past costs, i.e., costs that have been incurred to implement the existing program. Past costs, costs that have been incurred, are called sunk costs. Sunk costs are irrelevant for future decisionmaking (Smith and Dittman, p. 27).

Nevertheless, the hospital debt does deserve some attention. The construction of hospitals usually requires borrowing to cover capital expenditures. The construction costs are usually bond financed and presumably the outstanding debt would have to be repayed if the hospital were closed. The repayment can be ignored in most cases when a national accounting stance is used. The debt liquidation results in a transfer from Community B to the bond holders when the debt is repayed and should not be included. However, if the accounting stance was centered on Community B the debt repayment would enter into the cost calculations when the majority of the outstanding bonds are held by individuals outside of the community.

Summary

This chapter presented two different cost-benefit approaches to evaluate the net benefits resulting from the closure of a rural hospital. The final formulation presented -- the economic approach -- involves comparing the willingness to pay for hospital services with the opportunity cost of providing the services by two hospitals versus one hospital. Other important costs were identified. These include 1) travel costs expended by individuals after the closure of their hospital, and 2) the cost due to involuntarily assumed risk. Furthermore, the distribution of the benefits resulting from the closure were examined. It is expected that individuals in Community A will benefit as a result of the closure of Hospital B due to the reduction in the price of hospital services. This may or may not hold for individuals in Community B. The price reduction must be compared with the resultant increase in risk and travel costs. It is also expected that there will be a redistribution of economic activity away from Community B due to the closure of their hospital in the long run. This should be included when the accounting stance is centered on Community B.

Chapter 3

ESTIMATION PROCEDURE

The estimation procedure in this chapter will be developed as though one of two hospitals in an area will close. In reality, a closure likely would affect more than two hospitals. Displaced consumers may have a choice among a number of hospitals and empirical analyses must be consistent with the range of choices. Nevertheless, the methodology developed in this chapter can be applied to as many hospitals as is necessary.

The estimates of benefits and costs of hospital closures involves three critical variables; a measure of the quantity of hospital services, demand for hospital services, and costs of hospital services. This chapter will develop these critical measures and apply them to the case of the closure of one of two hospitals in an area.

The Quantity Variable

The quantity of hospital services will be measured by patient days in this analysis. This variable is 1) consistent with other empirical estimates that will be employed, and 2) is consistent with readily available hospital data. Other approaches which do not fulfill these requirements are:[10]

1. Intermediate inputs
2. End results or health levels

3. Episode of illness

4. Health services

5. A composite of one or more of the above

Certain problems are still evident when patient days are used as the quantity variable in the analysis. Each patient day will consume varying proportions of admission-specific, stay-specific, and diagnosis-specific services which will make the cost per patient day differ within and across hospitals. Admission-specific services are independent of the diagnosis and length of stay. Examples are blood and other tests which may be required shortly after admission. These tests and the inherent clerical work make the first day of hospitalization relatively expensive and patient days will not accurately reflect these services unless turnover is explicitly concerned. However, the hospital cost functions that will be employed in this analysis control for turnover and should capture the effects of these services on hospital costs. Stay-specific services and the cost of these services are adequately captured by patient days. Diagnosis-specific services are largely determined by the suspected diagnosis and the severity of the patient's condition. Different diagnoses demand different services and treatments; more heterogeneous diagnoses imply more heterogeneous patient days. Services among rural hospitals are much more homogeneous than in the hospital system as a whole. Furthermore, the cost functions control for the services offered and should somewhat control for the differing case/mix of the hospitals under investigation. Therefore, patient days are a reasonable approximation of output for use in this study.

The Demand Curves

The specification of demand functions allow the estimation of gross benefits and the calculation of price changes that come about due to hospital closures. The quantity consumed by each community can be determined with reference to the total number of patient days provided by each hospital. To determine a point on the demand curves, an average price per patient day paid directly by consumers is needed. The administered price can be approximated by the average revenue per patient day, excluding non-patient generated revenues. An approximation of the insurance coverage of the community is the proportion of hospital patient revenues obtained through direct payments from consumers, rather than third parties. The proportion of the total billings actually paid by patients is difficult to determine and a range of values will be used to approximate the community's insurance coverage. The copayment rates that will be used are 5 percent, 15 percent, and 25 percent. This range should cover the actual insurance coverage and will illustrate the sensitivity of the results to the assumed copayment rate. Multiplying these proportions by the administered price gives an approximate price faced by community residents

(Feldstein, p. 859). The use of this estimate in combination with the observed patient days provided by the community yields a point on each community's demand curve for hospital care.

The shape of the demand curve is critical for the estimation of willingness to pay and price changes resulting from a hospital closure. Figure 3-1 illustrates the sensitivity of price, hence total willingness to pay, to the slope of the demand curve for hospital services in Community A. Total willingness to pay is estimated by the area under the demand curve up to the quantity consumed. The demand curve D_A, provides an estimate of ACQ_AO and the demand curve D'_A yields an estimate of BCQ_AO for willingness to pay. Comparison of the two estimates illustrates the sensitivity of total willingness to pay to assumptions

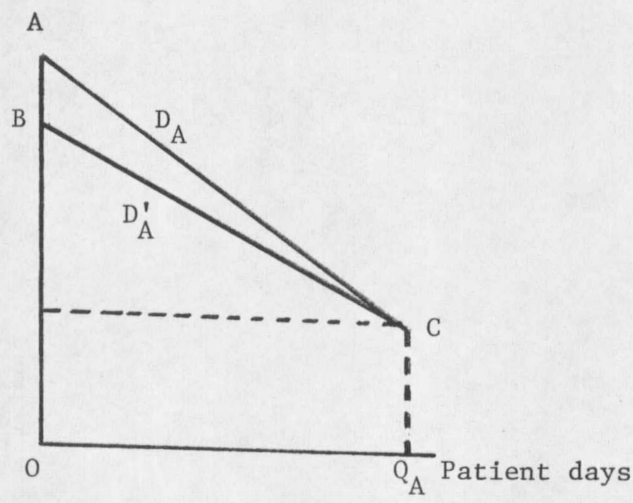


Figure 3-1. Total willingness to pay by Community A given two alternative slopes of their demand curve.

about the slope of the demand curve. Assume, for example, that D'_A accurately reflects the demand curve for services at Hospital A. Estimation of gross benefits of Hospital A using D_A would overestimate benefits of the hospital by ABC. In general, a steeper slope yields higher estimates for willingness to pay.

Price elasticities provide information about the slope of demand curves and can be used to construct linear demand curves. The price elasticity of demand is defined as the proportional change in quantity purchased divided by the proportional change in price and measures the responsiveness of quantity demanded to a price change. Mathematically, price elasticity, N_{xx}, is given by:

$$N_{xx} = \Delta x/x \big/ \Delta P_x/P_x = \frac{\Delta X}{\Delta P} \cdot \frac{P_x}{X}$$

where Δx represents the change in quantity demanded and ΔP_x is the change in price. Given price elasticity estimates and a point on the demand curve, the slope of the demand curve can be estimated. For example, assume the price elasticity and initial price-quantity relationship is known. Algebraically, the formula can be solved for the slope, $\frac{\Delta x}{\Delta P_x}$, of the demand curve.

The literature presents various price elasticity estimates for medical care, in general, and hospital care in particular. Estimation of the price elasticity for medical care is complicated by the lack of well-defined quantity and price variables. These variables ideally should be specified to reflect consumer preferences and the price consumers perceive. Various approaches are used in the literature.

Davis and Russell (Davis and Russell, p. 109) estimated price elasticities for both inpatient and outpatient care. Aggregate state level data (1969) from 48 states were used as a basis for the study. The quantity variables used for estimation of inpatient price elasticities were admissions and mean length of stay. Inpatient revenue per patient day, inpatient revenue per admission, and an average room charge were used to specify the price variable. Each price variable yielded different results, as would be expected. Estimation with inpatient revenue per patient day as the specified price variable resulted in a statistically insignificant coefficient. The use of inpatient revenue per admission resulted in an elasticity estimate of -0.32. The room charge proxy for price resulted in an elasticity estimate of -0.46.

Martin Feldstein (Feldstein, p. 853) used aggregate state data for the period 1958-1967 as the basis for his study. Constant price elasticities were estimated for mean length of stay and admissions taking into account the role of insurance. The price to the consumer was defined as the ratio of average net price to average gross price to capture the effects of insurance. The estimated elasticities were -0.63 for admissions and -0.49 for mean length of stay.

Rosett and Huang (Rosett and Huang, p. 281) used individual data from the 1960 Survey of Consumer Expenditures to estimate elasticities. These data consisted of the expenditures of approximately 10,000 urban and rural households and, therefore, differed from the aggregate data used in previous studies. Moreover, Rosett and Huang employed a different approach in defining the quantity variable. Their proxy was expenditures on hospitalization and physician services. The price variable used was the net of insurance price to consumers. The estimated price elasticities ranged from -0.35 to -1.5 with coinsurance rates of 20 and 80 percent, respectively. It appears that as the portion of the bill payed by consumers increases the demand for medical care becomes more elastic; that is, quantity demand becomes more responsive to price changes.

Phelps and Newhouse (Phelps and Newhouse, p. 1) obtain different price elasticity estimates using methodology similar to that employed by Rosett and Huang. Quantity was measured by patient days. A coinsurance range of zero to 25 percent was used for estimation. The lower coinsurance rates resulted in an arc elasticity of -0.07 for patient days.

Phelps and Newhouse (Phelps and Newhouse, 1974, p. 1) offer different price elasticity estimates in a more recent study. Employing data collected by a 1963 survey conducted by the Center for Health Administration, the price variable was defined as the difference between gross price and net price paid and the dependent variable was defined as expenditures. The estimation resulted in elasticities of -0.13 to -0.29 for hospital length of stay, depending on the estimation technique used.

The estimation of gross benefits of each hospital will be undertaken for various assumptions about the slope or price elasticity of the demand curve. A range of elasticities will be employed that cover most of the empirical work. The arc elasticity of -0.07 (Phelps and Newhouse, p. 7) is used for the upper bound gross benefit estimates. Middle and lower bound estimates will be obtained using elasticities of -0.25 and -0.50, respectively. These elasticities allow the use of the following formula for the calculation of gross benefits:[11]

$$GB = \frac{1}{2} \frac{P_1Q_1}{N} + P_1Q_1$$

where P_1 is the estimated price to consumers, Q_1 is the quantity consumed and N is the assumed price elasticity of demand. Furthermore, linear demand curves can be estimated algebraically. This will be useful for estimating the demand for the remaining hospital after the closure.

Marginal Cost Functions

The area under the marginal cost curve provides an estimate of the opportunity cost of the resources employed to produce hospital services. These functions are needed to estimate the cost savings resulting from a closure. Finch and Christianson indirectly provide this information. Their study investigates the average cost per patient day of rural hospitals in five western states -- Montana, Wyoming, Idaho, Utah, and Nevada -- over the years 1971-1979. Using quadratic and logarithmic specifications, they estimated average cost per patient day controlling for variables such as the number of beds, occupancy rates, the year and services provided by the hospitals. These average cost functions can be used to obtain marginal cost functions. The steps are illustrated for the quadratic specification. Define average costs as:

$$1) \quad AC = a_0 - a_1U + a_2U^2$$

where a_0 is defined to be the combined effects of the number of beds, the year, and a host of other variables representative of the hospital and U represents the hospital's occupancy rate. The estimated coefficients for the utilization and utilization squared are a_1 and a_2 respectively. The occupancy rate variable can be converted to patient days using:

$$2) \quad U = \frac{\text{census}}{\text{beds}} = \frac{\frac{TPD}{365}}{S}$$

where S equals the number of beds and TPD equals total patient days. Substitution of this identity into the model yields:

$$3) \quad AC = a_0 - \frac{a_1 \, PD}{S \; 365} + \frac{a_2 \, PD}{(S \; 365)^2}$$

The next step is to convert average cost per patient day to total cost. This is accomplished by multiplying the equation by patient days:

$$4)\quad AC(PD) = TC = a_0 PD - \frac{a_1 PD^2}{(S\ 365)} + \frac{a_2 PD^3}{(S\ 365)^2}$$

The marginal cost function is obtained from the total cost function by partially differentiating total cost with respect to patient days:

$$5)\quad MC = \frac{\partial TC}{\partial PD} = a_0 - \frac{2a_1 PD}{S\ 365} + \frac{3a_2 PD^2}{(S\ 365)^2}$$

An estimate of the opportunity cost of the resources used to produce hospital services is provided by the area under the marginal cost function. Mathematically, the estimate is provided by:

$$\int_0^{TPD} a_0 - \frac{2a_1 PD}{(S\ 365)} + \frac{3a_2 PD^2}{(S\ 365)^2}\ dPD$$

$$= TPD\left[a_0 - \frac{2a_1 TPD}{2(S)365} + \frac{3a_2\ TPD^2}{3(S\ 365)^2}\right]$$

This integral of the marginal cost function applied to each case estimates the total cost of providing the specified number of patient days by Hospital A, Hospital B, and Hospital A after B is closed.

The estimate obtained from the marginal cost function will be used rather than relying on actual hospital data for a number of reasons. First, the marginal cost estimate and the methodology used to obtain the estimate are consistant with the cost-benefit literature. Secondly, hospital cost data may potentially bias the analysis if costs differ from year to year due to unexplained factors. Most importantly, the estimates obtained from the marginal cost functions will be consistent with the estimated total cost of providing services by Hospital A after the closure which is unknown and cannot be obtained from actual hospital data.

The estimation of net benefits from the operation of Hospitals A and B is possible at this point. The number of patient days provided by each hospital can be ascertained from hospital data. The price to consumers at each hospital can be estimated as described previously. This information, in conjunction with the assumed price elasticities, allows the calculation of net benefits resulting from each hospital:

$$NB_i = \frac{\frac{1}{2} P_i PD_i}{N} + P_i PD_i - PD_i \left[a_{0i} - \frac{2a_{1i} PD_i}{2S_i 365} + \frac{3a_{2i} PD_i^2}{3(S_i 365)^2} \right]$$

where the subscript i represents the hospital in question. The net benefits to the communities from the operation of Hospitals A and B are estimated by adding the net benefits resulting from each hospital.

It is also necessary to estimate the net benefits resulting from the operation of Hospital A after the closure of Hospital B. The marginal cost function of Hospital A has been specified. Considerable attention needs to be given to determining the demand for Hospital A after the closure.

The Demand for Hospital A After the Closure of Hospital B

Estimation of the gross benefits resulting from the operation of Hospital A after the closure of Hospital B depends on the new demand curve for care in Community A. The closure of Hospital B should not affect the demand curve for care in Community A by its previous consumers, assuming the quality of care is the same and the hospital does not experience excessive crowding. Attention must be devoted to the effect of the closure on Community B's demand for hospital care, since Community A's demand function should not change as a result of the closure.

Assume the demand functions for each community are known, both facilities offer the same services, and that locational considerations are unimportant. An estimate of the new demand function for care at Hospital A may be obtained by summing horizontally the demand curves for care in each community. In Figure 3-2, assume the two demand functions are estimated to be $Q_A = \alpha - b_1P_A$ and $Q_B = \beta - b_2P_B$ for hospitals A and B, respectively.

The new demand curve, D_{A+B}, is formed by summing horizontally the respective quantities that would be purchased at each price. Using this procedure, the demand curve D_{A+B} is estimated by ABC. Algebraically, the same demand function is:

$$Q'_A = \alpha + B - (b_1+b_2)\ P_A$$

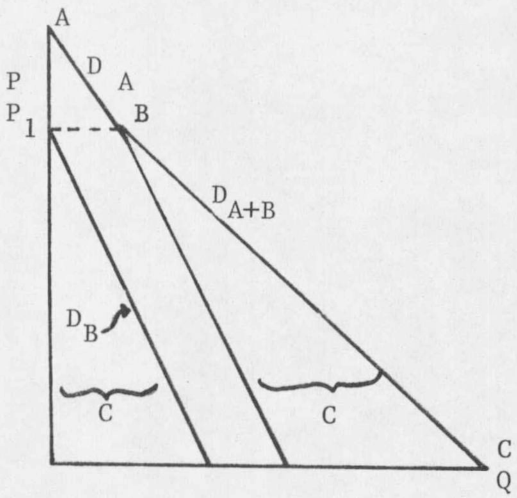


Figure 3-2. The Area's Demand for Hospital A After the Closure.

for $P < P_1$ and

$$Q'_A = \alpha - b_1 P_A$$

for $P > P_1$. Notice the discontinuity at P_1. The slope of D_{A+B} is b_1 for prices greater than P_1 and (b_1+b_2) for prices less than P_1.

This new demand curve should accurately reflect the differing services provided by the two institutions, if the same services assumption is dropped. However, if Hospital A lacks some services offered by Hospital B the horizontal summation will overestimate the demand for care in Community A. The previous consumers would have to attend another hospital which offers the service or do without. This should not present a problem because the likely candidates for closure will typically be low service level hospitals.

Thus far locational considerations have been ignored. The location of Community B in relation to Community A has important implications about the demand for care of individuals of Community B at Hospital A. The closure of Hospital B implies that some individuals in Community B will have to travel further to consume medical services. The increased travel time and its associated cost will act as an alternative rationing device. The negative effect that this can have on the demand for medical services is well documented in the literature. Acton (Acton, 1975, p. 610) concludes that as the time price increases in relation to the out-of-pocket payment, demand will become more sensitive to time prices. For example, the demand for free medical care will be more sensitive to time price than will non-free forms of care. Furthermore, individuals with a high opportunity cost of time will demand less time-intensive forms of care. The general findings are supported by other research. For example, a 10 percent increase in travel time to outpatient clinics among a low-income urban group resulted in a 10 percent reduction in physician visits (Acton, 1973). A group of largely middle-income individuals living twenty miles from a clinic had only two-thirds the visits of those living within five miles (Phelps and Newhouse, 1972). When a student health clinic was moved from an average 7.5 minute walk to a twenty minute walk and students faced no money charge for their visits, visits fell by 40 percent (Simon and Smith, p. 64). Furthermore, increased travel time can alter the case mix of a medical facility. Individuals who are more sensitive to time price are those with more routine complaints. Those with severe cases will be relatively insensitive to increased time price (Simon and Smith, pp. 64-65; Ciocco and Altman).

Since the exact effect of the increased travel time (and reverse Roemer effect) on Community B's demand for care is not known, a range of new demand curves will be used. The summation of the previous demand curves of the communities will be used for an upper bound estimate. A lower estimate of the new demand curve for care in Community A will be obtained by summing Community A's original demand with a ten percent reduction in Community B's demand.

The increased travel time and its costs will alter the price elasticity of demand for hospital services. The increased time price implies that the price elasticity will become less inelastic or the demand curve will be flatter. The reduction in aggregate demand due to travel time should capture some of the effects on gross benefits due to the altered price elasticity but no attempt will be made to adjust for this directly.

Price Reduction Due to the Increased Utilization of Hospital A

Assume the construction of a demand curve (of the total area) for hospital services in Community A is completed. The estimation of the area's total willingness to pay necessitates the establishment of the price-quantity relationship that will result after the closure. The quantity of services demanded by Communities A and B depends on the price that results after the closure. The price of hospital services in Community A needs to be approximated.

Finch and Christianson's (Finch and Christianson) model will be used to predict the average cost per patient day at Hospital A. The average cost estimate can be adjusted to reflect the insurance coverage of the communities to estimate the new price to consumers. To estimate the price and quantity demanded, the demand function and the cost to consumer function (adjusted AC function) must be solved simultaneously. This procedure will be used to approximate the price and quantity that will be demanded under the different assumptions about the new demand curve for care in Community A. Assume the aggregate demand function is of the following form:

1) $Q = \alpha - B P_c$

where P_c is the price to consumers at the time of purchase and Q is the number of patient days. It is assumed that the price to the consumers is some function of the average cost of providing hospital services or:

2) $P_c = {}_cP_A = cAC = c\,[a_0 - a_1 Q + a_2Q^2]$

where AC is the average cost function, c reflects the insurance coverage of the community and P_A is the administered price. These two equations must be solved simultaneously to estimate the number of patient days that will be consumed or:

$$3)\quad Q = \alpha - Bc\ [a_0 - a_1 Q + a_2 Q^2]$$

Solving these equations simultaneously yields:

$$4)\quad \alpha - Bca_0 + (Bca_1 - 1)Q - Bca_2 Q^2 = 0$$

This equation is solved for the positive value of Q, which is the new number of patient days provided by Hospital A. The price that results is approximated by evaluating the average cost function at the new quantity Q and the new price to consumers is P_c = c AC (evaluated at Q).

The estimated price and quantity of services combined with the estimated demand curves allow the calculation of net benefits resulting from the operation of one area hospital. With this estimate in hand, the approximation of the first round net benefits from the closure is possible. To obtain these estimates, the net benefits of two area hospitals are subtracted from the net benefits to the area from the operation of one hospital. Attention is now turned to additional costs not captured thus far because locational considerations have not been considered except for its influence on the demand function for hospital care.

Travel Costs

The closure of Hospital B will force some of its previous consumers and visitors to travel greater distances for hospital care. In the process, resources will be expended. The resources used by individual i can be approximated by:

$$\left[TC_i = 2\ (w_i h_i + c_i m_i \right]$$

where w_i equals the value of travel time; h_i is the time involved, c_i is the cost per mile of operating the vehicle, and m_i is the number of miles traveled one way. The dollar value of the resources expended by patients may be approximated by summing the formula over the number of admissions to Hospital A of individuals of Community B. The number of admissions of these individuals may be obtained from the number of patient days consumed and the mean length of stay. To estimate the value of the resources expended by visitors, the formula can be summed over the number of patient days consumed by individuals of Community B. This assumes a trip will be made for every day of hospitalization and only by one individual.

The formula and its components warrant further discussion. Because time and operating costs per mile vary inversely, travel costs are dependent on trip speed requiring assumptions on the speed traveled. The assumed travel speed should represent the type and condition of the roads each individual must travel. Without a detailed point of origin study, this is impossible to determine. For the purpose of this study, the difference in distance will be based on the extra travel involved to arrive at Hospital A from Hospital B. If the roads are interstate or good two-lane highways, it will be assumed the speed traveled is 55 miles per hour. Weather can be taken into account by varying travel speed over the time of year.

The value individuals place on travel time must be investigated. Research, using the implied value approach, has addressed this issue. The implied value approach involves obtaining a direct estimate of the value of time from observed behavior. Individuals often have a choice of alternative travel modes in their daily commuting decisions, each with a different travel time and explicit cost. The choice of a travel mode reveals the individual's preferences for time savings versus extra costs. Observation of the differences in travel time and costs allows the estimation of the trade-off between time and money.

Beesley used the implied value approach to estimate the value individuals place on travel time. He found that 30 percent to 50 percent of the wage rates equals the implied value of time for these individuals (Beesley, p. 182). Other research (Vickerman, p. 1; Howe, p. 113) supports a range of 25 percent to 50 percent. In light of this discussion, ". . . it is recommended that estimates obtained from a simple wage rate analysis be modified by reducing this from 50 percent to 75 percent" (Anderson and Settle, p. 64). Furthermore, this component of travel costs depends on the number of individuals per car making the trip. For example, two individuals would expend twice the time costs relative to the time cost of one individual. The upper bound travel cost estimates will assume that two people make each trip and a lower bound estimate can be obtained by assuming only one individual makes each trip.

To estimate travel costs, average wage rates for the community, average speed, cost per mile of operating a vehicle, and the number of diverted patient days are needed. Average community wage rates will be approximated from county data on the number of employees and total payroll for the first quarter of 1978 (County Business Patterns). The average speed of travel will be assumed to be 55 miles per hour in all the case studies. Operating costs per mile estimates at 18 cents and 25 cents (AAA, 1979, p. 3) will be used for lower and upper bound estimates, respectively. The number of diverted patient days will be determined by the specifics of each case study.

Risk of Morbidity and Mortality

The necessity of travel by Community B will result in an increase in the risk of premature death and pain and suffering. To obtain a direct estimate of Community B's willingness to pay to avoid this imposed risk, the community's indifference curve between risk and money and the change in the probability or morbidity and mortality would have to be estimated. Questionnaires can be designed to obtain data to estimate the indifference curve of the community (Acton, 1976, Schelling). However, an accurate estimate of the actual increase in risk is difficult to obtain so the actual estimation of this component of cost will not be undertaken. If the costs imposed by a rural hospital closure exceed the benefits generated inclusive of all other categories, the closure is undesirable and this component of cost would support further that conclusion. On the other hand, if the benefits exceed the costs, ignoring risk, the question of whether the gainers from the closure could compensate the losers with the purchase of ambulance services will be addressed.

Estimation of the Net Benefits of a Closure Using the "Planning Approach"

Chapter 2 presented two different formulations that can be used to approximate the net benefits of a closure. These were the economic and planning approaches. The previous discussion outlined the necessary parameters that must be used to estimate the economic formulation. With this completed, attention will be devoted to the planning model which will be used for a comparison of the results of the two different formulations.

The key assumptions of the planning model are: 1) the communities and the area need some preconceived service level, 2) the services are homogeneous across alternatives, and 3) prices of the services are unimportant in consumer decisions. The assumptions imply that the gross benefits accruing through the provision of hospital services can be ignored. The gross benefits that result from the closure are simply a sum of the gross benefits resulting from the two facilities. Therefore, demand curves for hospital services can be disregarded. The net benefits resulting from a closure in this formulation are the resource savings that would result under the one hospital system, corrected for travel and risk costs imposed on the community with the closed hospital.

In order to implement the planning model, marginal cost functions for Hospitals A and B are needed to provide an estimate of the resource savings that accrue as a result of a closure. First, the marginal cost functions are used to estimate the opportunity cost of the resources used by two hospitals to provide the existing service levels, as in the economic model. An upper bound estimate of the cost savings is provided by comparing this estimate with the opportunity cost of the resources that would be used by Hospital A to provide the same service level to the area. This is estimated by the marginal cost function at Hospital A evaluated at the new output level, which is the sum of the old outputs. Planners, however, may view a lower service level as the likely outcome from a closure due to the reverse Roemer effect. For example, McClure provides an estimate that a 10 percent reduction in bed capacity will induce approximately a four percent reduction in patient days at current use and bed levels (McClure, p. 30). This estimate, in conjunction with information on the area's hospital system, can be used to provide a lower bound estimate of the cost savings. Travel and risk costs would correct these estimates for additional costs not captured by the first-round approximation. The method for quantifying the costs was presented previously and can be used here also.

This chapter presented estimation procedures for evaluating the effects of a rural hospital closure. Two models were presented, the economic and planning models. The economic model will be used to estimate the net benefits of the hypothetical closures of three rural hospitals. These results will be compared with estimates of net benefits obtained by using the planning methodology. Many assumptions were made to bound the estimates to illustrate the sensitivity of net benefits to these assumptions. Table 3-3 summarizes parameters that will be varied in the process of estimating the net benefits of a closure.

TABLE 3-1

VALUES ASSUMED FOR ANALYSIS

Item	Level of Assumed Values: High	Medium	Low
Price Elasticities	-.07	-.25	-.5
Proportion of Total Billing Paid Directly by Customers	25	15	5
Marginal Cost Function	Quadratic		Log
Demand Function After Closure	Addition of Previous Functions		All of A's demand plus 90% of B's
Travel Cost			
No. of individuals/car	2		1
Value of time	50% of Wage		25% of Wage
Cost per mile	25¢		18¢

Chapter 4

APPLICATION OF THE COST-BENEFIT FRAMEWORK

This chapter applies the economic framework to four types of hospital systems. The first example will present an actual closure. The remaining examples will make use of artificial variations of the actual case to identify factors influencing the net benefits of a closure.

Example I: The Actual Case

Hospital B in this example has 34 short-term acute care beds. The average occupancy rate of the facility was 39.4 percent in the year under investigation. The hospital provides specialized services that are typical of many rural hospitals: intensive cardiac care, pharmacy, blood bank, inhalation therapy, and emergency services.

Hospital B was chosen for this study for a number of reasons. First, Hospital B and its alternative facility are the only facilities in their respective communities which provide short-term acute care. Therefore, the application of the framework developed is relatively simple to apply to this case. Secondly, the low occupancy rate of Hospital B makes it a likely candidate for a closure. The alternative facility is located approximately 90 miles away from Community B. It has a relatively high occupancy rate which, in conjunction with the distance between facilities, provides an example of the closure of a rural hospital where it is anticipated that new benefits will be small.

Hospital B is located in a town of approximately 3,000 individuals. The county population was roughly 16,000 in 1975, which translates to four individuals per square mile. The county population declined 12.7 percent from 1970-1975 (City County Data Book, 1977). However, the county population grew by approximately 45 percent during the 1960s (Table 4-1). The major industries of the area are forest products and mining. The county unemployment rate was 10.3 percent in 1970 compared with the state average of 6.2 percent for the same period.

Hospital A, the alternative facility to Hospital B, is a relatively large rural facility with 91 short-term beds. It offers virtually all services with the exception of very specialized services such as an organ bank and an open-heart surgical facility. Therefore, this facility has the service offerings to treat all of the patients receiving care at Hospital B. The average occupancy rate was approximately 78 percent for the year under investigation.

County A has a 1975 population of approximately 13,000 individuals. From 1970-1975, the county population increased by roughly two percent (Table 4-1). The county population fell approximately 10 percent in the decade of the sixties. The major industries of the area are forest products and tourism. The county unemployment rate was near 10 percent in 1970.

TABLE 4-1

COUNTY STATISTICS

Item	Unit	County B	County A
Land Area	sq.mi.	3,714	5,137
Population in 1975	number	16,372	12,925
Pop. Density	sq.mi.	4	3
Pop. Over 1965	percent	7.2	15.2
Pop. Change 1970-75	percent	-12.7	2.0
Net Migration 1960-70	percent	-18.8	-1.1
Pop. change 1960-70	percent	44.1	10.0
Unemployment in 1970	percent	10.3	9.8
Per Capita Income in 1974	percent	3,947	3,894
Median Family Income in 1969	percent	9,711	8,567
Physicians in 1975	number	8	62

Source: The City County Data Book (1978).

The net benefit estimates suggest that policies to promote the closure of Hospital B would not be desirable. The final net benefit estimates, inclusive of risk compensation and travel costs, ranged from $177,248 to a low $-195,586 (Table 4-2). The results obtained using the quadratic specification were negative ignoring the additional costs. All of the net benefit estimates were negative except for the high demand estimate adjusted using the lower bounded costs. In reality, this positive net benefit estimate could be reduced further. The closure of Hospital B in this example resulted in a projected occupancy rate of approximately 90 percent, implying Hospital A might react to the closure by adding additional services or personnel. This would increase the cost and further reduce the net benefits of closing Hospital B.

The net benefits of Hospital A after the closure of B were sensitive to the assumed copayment rates and price elasticities, with the greatest net benefit estimates occurring for the price elasticity of .07 and copayment rate of 25 percent. Discussions with various hospital administrators concluded that a copayment rate of 15 percent best reflects the prevalent insurance coverage. Furthermore, the price elasticity of .07 appears to be the best estimate of this parameter. The "most likely" net benefit estimates of the closure making use of these two parameter values, are presented in Table 4-2, line 5.

TABLE 4-2

SUMMARY OF THE RESULTS OF EXAMPLE I

Row	Case	Demand and Travel Assumptions	Cost Function	
			Log	Quadratic
1	Net Benefits of B	ε = .07, c = .15	90,655.90	$ 423,338.00
2	Net Benefits of A	ε = .07, c = .15	1,709,258.30	3,456,744.10
3	Net Benefits of A & B		1,799,914.20	3,880,082.10
4	Hospital A, After the Closure of B	a. High, (ε=.07, c=.15, no reduction)	2,217,087.00	3,479,404.70
		b. Low, (with reduction)	2,053,123.60	3,373,698.30
5	Net Benefits of Closure	a. High, (4a - 3)	417,171.80	-400,677.40
		b. Low, (4b - 3)	253,209.40	-506,383.80
6	Travel Costs*	a. High, (high T.C., reduction in demand)	353,795.52	
		b. Low, (low T.C., no reduction in demand)	220,923.51	
7	Net Benefits adjusted for travel costs	a. High, (5a - 6b)	196,248.29	
		b. Low, (5b - 6a)	-100,586.12	
8	Ambulance Cost	a. High, (Complete System)	95,000.00	
		b. Low, (1 ambulance)	19,000.00	

*High and low travel costs are consistent with the demand estimates used to calculate the net benefits of the closure.

Comparison of these results illustrates the importance for net benefit estimation of the true nature of the underlying cost functions for the provision of rural hospital services. Since the logarithmic average and marginal cost functions decline throughout, the additional cost of adding a patient day always is less than the previous. On the other hand, the quadratic average cost function reaches its minimum value at an occupancy rate of approximately 73 percent and the minimum of the marginal cost function is at an occupancy rate of approximately 48 percent. The quadratic specification results in an increasing cost of adding patients even at low occupancy rates. This explains the differing results obtained by the use of each cost function. The occupancy rate of Hospital A was initially 78 percent, which is in the range of increasing marginal costs using the quadratic specification. After closure of Hospital B, Hospital A's occupancy rate increased to 93.2 percent using the logarithmic cost function and 94.4 percent using the quadratic specification. It is difficult to judge which net benefit estimates are the most realistic. However, the logarithmic specification seemed to do a better job predicting the initial cost per patient day. Furthermore, the logarithmic specification resulted in a slightly better statistical fit of the original sample of rural hospitals from which it was estimated (Finch and Christianson, p. 28).

Further adjustments in the net benefit estimates are necessary to reflect travel and risk costs borne by individuals in Community B as a result of the hospital closure. Both positive net benefit estimates were adjusted to reflect the travel costs of patients and visitors. High and low travel cost estimates were calculated as $61.07 and $36.94 per trip, respectively. Community B's demand equations and the new price estimates were used to estimate the number of patient days that would be consumed by Hospital B patients at Hospital A after the closure of B. These patient day figures indicate the number of trips made by visitors from Community B. The number of trips made by patients also was calculated assuming that the average length of stay at Hospital A would remain constant after the closure. The number of admissions to Hospital A by residents of Community B was calculated by dividing the patient days consumed by the average length of stay at Hospital A before the closure. The estimated number of admissions allows the approximation of travel costs of patients of Hospital A from Community B. The travel cost estimates were used to adjust the initial net benefit estimates (Table 4-2). The inclusion of travel costs reduced the high net benefit estimate to $196,248.29 and the low estimate to $-100,586.12.

The remaining adjustment to the net benefit estimates reflects the cost of reducing the risk resulting from the closure of Hospital B. The additional risk can be reduced by improving the county ambulance service. Assume, for example, the community were to add a fully staffed service with a paid Emergency Medical Technician available

24 hours a day, two additional ambulances, a VHF communication system and a new building to its current ambulance service. Assuming each vehicle averages 11,000 miles per year it has been estimated this system would cost $95,000 per year to operate, including interest and depreciation costs (Doeksen, Anderson, and Whitlow, p. 18). (This cost estimate was conducted in the same year as the data employed by this study. The mileage used may be unrealistic in this example and increased average mileage would increase the cost estimate.) The cost of this system would be reduced to approximately $58,000 if volunteers were used half of the time. Costs of new ambulances range from $26,000 to $19,000 depending on the type of ambulance used, ignoring any operating or maintenance costs (Doeksen, Anderson, and Whitlow, p. 13). The extreme cost estimates are to adjust the net benefit estimates to compensate Community B for the increased risk. The inclusion of these estimates results in final net benefits of the closure ranging from a high of $177,248.29 to a low of $-195,586.12.

Example II

This example illustrates the effects of closing a small low occupancy hospital when patients are diverted to two high utilization, relatively large hospitals. The results of this artificial example imply that the closure of Hospital B would be undesirable from a cost-benefit standpoint (Table 4-3). The net benefits are negative except

TABLE 4-3

SUMMARY OF NET BENEFIT ESTIMATES FROM EXAMPLE II

Row	Net Benefit Estimate	Demand Assumptions	Cost Function Specification	
			Log	Quadratic
1	Net Benefits of B	ε = .07, c = .15	90,655.90	423,338.00
2	Net Benefits of A & C	ε = .07, c = .15	1,709,258.30	3,456,744.10
3	Net Benefits of A,B &C	Estimates (1. + 2 + 2)	3,509,172.50	7,336,826.20
4	Net Benefits of Hospital System after the Clsoure (2 A's remaining)	a. High Estimate (No Demand Reduction)	3,904,546.80	6,926,196.50
		b. Low Estimate (10% Demand Reduction)	3,748,061.80	6,810,436.80
5	Net Benefits of the Closure	a. High Estimate (4a - 3)	395,374.30	-410,629.60
		b. Low Estimate (4b - 3)	238,889.30	-526,389.40
6	Travel Costs*	a. High Estimate (High T.C., Reduction)	325,030.90	
		b. Low Estimate (Low T.C., No Reduction)	220,438.38	
7	Net Benefits adjusted for Travel Costs	a. High Estimate (5a - 6b)	174,935.92	
		b. Low Estimate (5b - 6a)	-86,141.60	

*Based on assumption that Hospital C is 90 miles from Community B. High and low estimates travel cost are consistent with demand estimates.

when obtained by the use of the logarithmic cost specification adjusted by lower bound compensation for risk and travel costs.

Example II assumes that two hospitals would be affected by the closure of Hospital B. The two remaining facilities (A and C) are assumed to be identical to Hospital A in the previous example. Each of the remaining facilities are assumed to provide half of the displaced demand which results from the closure of Hospital B.

The net benefit estimates obtained in this example again were sensitive to the specification of the cost function (Table 4-3). The net benefits estimates of the closure are lower than in the previous example. The projected patient days provided by Hospital A are less than in the previous example and the closure results in higher average and marginal costs, relative to Example I, when the logarithmic cost function is used. However, the cost of adding patient days increases for both hospitals when the quadratic specification is used. The rapidly increasing costs of both hospitals resulting from the closure further reduce the net benefit estimates relative to the first example.

The net benefits obtained using the logarithmic cost function again must be adjusted for travel costs. There is no need to adjust the quadratic results because they are negative, indicating that the closure is not desirable. Hospital A, as before, is 90 miles from Community B. Net benefit estimates of the closure, inclusive of travel costs to Hospital A only range from $240,240.62 to $285,169.72

for the high and low travel costs, respectively. Hospital C would have to be 115 to 233 miles from Community B to reduce the net benefits to zero. For the low net benefit estimate, Hospital C would have to be 39 to 126 miles from Community B to exhaust the net benefits of the closure. These mileage estimates imply that net benefits would remain positive for most realistic distances between Community B and Hospital C. For illustrative purposes, it will be assumed that Hospital C also is 90 miles from Community B. This assumption allows the calculation of travel costs for all the displaced demand and the net benefits adjusted for travel costs (Table 4-3). The net benefits of the closure adjusted for travel costs range from $174,935 to $86,141 for the high and low estimates, respectively. These estimates are reduced further to a range of $155,935 to $-181,141 for the high and low estimates, respectively, when the cost of additional ambulance service is included.

Example III

The third hypothetical example represents a closure with patients diverted to a large and a small hospital. The remaining facilities are Hospital A and another hospital identical to Hospital B. As in the previous example, it will be assumed the displaced demand is divided equally among these remaining hospitals.

The results from this example suggest that the closure of Hospital B would not be desirable from a cost-benefit standpoint. However, the results from the use of the logarithmic specification would have been positive if Hospital A were nearer to Community B. Travel cost would have decreased enough for the low net benefit estimate to remain positive.

The net benefit estimates in this example are larger than in the previous examples. The first-round net benefit estimates ranged from $-220,940 to $434,537.70 (Table 4-4). The most dramatic increase was evident for the quadratic specification results. The increase is mainly due to the increased utilization of the small hospital. The projected occupancy rate of the small facility increased to just over 60 percent from the initial occupancy rate of approximately 39 percent. Assigning the patients to the lower utilization hospital decreased the marginal cost per patient day of the hospital which partially offset the increased marginal cost of the larger facility using the quadratic specification . Nevertheless, the net benefit estimates obtained from the quadratic specification were still negative.

Travel costs were handled in the same manner as in the previous example. For the high net benefit estimate, one-way distances to Hospital C that reduce the net benefits to zero were calculated to range from 118 to 262 miles for the high and low travel costs, respectively. Hospital C would have to be 42 to 134 miles from Community B to exhaust the low net benefit estimate.

TABLE 4-4

SUMMARY TABLE FOR EXAMPLE III

Row	Net Benefit Estimate	Demand Assumptions	Cost Function Specification: Log	Cost Function Specification: Quadratic
1	Net Benefits of B	ε = .07, c=.15	90,655.90	423,338.00
2	Net Benefits of A	ε = .07, c=.15	1,709,258.30	3,456,744.10
3	Net Benefits of C	ε = .07, c=.15	90,655.90	423,338.00
4	Net Benefits of A,B&C	Estimate (1 + 2 + 3)	1,890,570.10	4,303,420.10
5	Net Benefits of A & C after the Closure	a. High Estimate (High Demand)	2,325,107.80	4,232,005.70
		b. Low Estimate (Low Demand)	2,160,025.80	4,082,479.90
6	Net Benefits of the Closure	a. High Estimate (5a - 4)	434,537.70	-71,414.40
		b. Low Estimate (5b - 4)	269,455.70	-220,940.20
7	Travel Costs*	a. High Estimate (High T.C., Low Demand)	233,979.95	
		b. Low Estimate (Low T.C., (High Demand)	152,107.07	
8	Net Benefits adjusted for Travel Costs	High Estimate (6a - 7b)	282,430.63	
		Low Estimate (6b - 7a)	35,475.75	

*High and low travel costs used were consistent with the demand estimates.

Additional information can be obtained from the net benefit estimates if a specific location of Hospital C is used. Since Hospital C in the example is a small hospital which offers few services, the distance to the facility should be less for the patient allocation used to be realistic. It will be assumed that Hospital C is 30 miles from Community B which results in approximately 30 minutes travel time and makes Hospital B subject to the occupancy rate guidelines. With this assumption, travel costs were calculated and used to adjust the net benefit estimate (Table 4-4). The net benefit estimates inclusive of travel costs range from approximately 282,430 to 35,475 for the high and low estimates, respectively. These estimates were further adjusted to reflect the cost of compensating Community B for the additional risk resulting from the closure. The range of ambulance costs were presented previously. Adjusting the net benefit estimates to include travel and the "risk compensation" costs results in final net benefit estimates of approximately $263,430 to $-59,524 for the high and low estimates, respectively.

Example IV

This example assumes that both of the remaining facilities are small and identical to Hospital B. The initial occupancy rates of these hospitals are approximately 39 percent. Therefore, this example represents the most likely closure of a rural hospital by the appropriateness review process because the occupancy rates of all the area hospitals are low (see Chapter 1). As in the previous examples, it was assumed that each of the remaining facilities provide half of the displaced demand resulting from the closure of Hospital B.

The results of this example suggest the closure of Hospital B would be desirable from a cost-benefit perspective. Three of the final net benefit estimates were positive assuming the remaining facilities were 30 miles from Community B.

The net benefit estimates of the closure obtained from this example were positive regardless of the functional form of the cost functions (Table 4-5). The closure of Hospital B raised the occupancy rates of the remaining facilities to approximately 60 percent, depending on the cost specification used. These increased occupancy rates resulted in significant reductions in the average and marginal cost per patient day, and the net benefit estimates increased relative to the previous examples.

Neither of the remaining hospitals have a definite location in this example. The net benefit estimates and travel cost figures will be used to determine the minimum combined distance necessary to exhaust the net benefits of the closure. These one-way distances were estimated for the high travel cost estimates and are presented in Table 4-6. These distances increase by approximately 75 percent when lower bound travel cost estimates are used. The distance estimates suggest that

TABLE 4-5

SUMMARY TABLE FOR EXAMPLE IV

Row	Net Benefit Estimate	Demand Assumption	Cost Function Specification	
			Log	Quadratic
1	Net Benefits of B	$\varepsilon = .07$, $c = .15$	90,655.90	423,338.00
2	Net Benefits of A	$\varepsilon = .07$, $c = .15$	90,655.90	423,338.00
3	Net Benefits of C	$\varepsilon = .07$, $c = .15$	90,655.90	423,338.00
4	Net Benefits of A,B&C	Estimate (1 + 2 + 3)	271,967.70	1,270,014.00
5	Net Benefits of A & C	a. High Estimate (No Reduction in Demand)	745,668.70	1,537,814.80
		b. Low Estimate (10% Reduction in Demand)	571,989.70	1,354,523.00
6	Net Benefits of the Closure	a. High Estimate (5a - 4)	473,701.00	267,800.80
		b. Low Estimate (5b - 4)	300,022.00	84,509.00
7	Travel Costs *	a. High Estimate (Low Demand, High T.C.)	140,066.77	142,928.78
		b. Low Estimate (High Demand, Low T.C.)	82,312.82	83,775.44
8	Net Benefits Adjusted for Travel Costs	a. High Estimate (6a - 7b)	391,388.18	184,025.35
		b. Low Estimate (6a - 7a)	159,955.23	-58,419.78

*Based on distances of 30 miles to remaining facilities.

TABLE 4-6

MINIMUM COMBINED DISTANCES OF EXAMPLE IV

Demand Assumption	Cost Function: Log	Cost Function: Quadratic
	- miles -	
High Demand	174.5	62.7
Low Demand	146.9	21.7

the net benefits of the closure of Hospital B in this example would remain positive given realistic locations of the alternative facilities, except in the case of high travel cost estimates and the quadratic specification. Furthermore, the occupancy rate guidelines do not apply if a closure results in travel times to the remaining facilities of greater than 30 minutes. These distance estimates suggest that net benefits would remain positive.

Travel costs and net benefits inclusive of travel cost were estimated under the assumption that both hospitals were 30 miles from Community B. These distances would make Hospital B subject to the occupancy rate guidelines if the average speed traveled is 60 miles per hour, which is not unrealistic for rural areas and in emergency cases. Three of the four net benefit estimates remained positive after travel costs were included (Table 4-5). These estimates were adjusted further to reflect the costs of additional ambulance services or the "risk compensation" cost. The positive net benefit estimates remained of the same sign when this cost was included. The use of the logarithmic cost function resulted in final net benefit estimates of $372,388 and $64,955 for the high and low estimates, respectively. Net benefits range from $165,025 to $-153,419 under the quadratic cost specification.

Summary and Conclusions

This chapter presented four hypothetical examples of the closure of a rural hospital. Net benefits of the closure were estimated for each of the examples. In general, use of the logarithmic cost function resulted in positive first-round net benefit estimates regardless of the remaining hospital system. The logarithmic function declined throughout, therefore marginal cost per patient day declined as the closure increased the utilization of the remaining facilities. However, net benefits of the closure as estimated using the quadratic specification were sensitive to the utilization of the remaining hospitals. The quadratic marginal cost reaches its minimum at an occupancy rate of approximately 48 percent, therefore increasing utilization of the remaining hospitals resulted in increasing marginal costs per patient day. The only positive first round net benefit estimates using the quadratic specification were obtained in the example which assumed two small low-occupancy hospitals received additional patients due to the closure.

Travel costs were important in the initial examples, partially because of the distance and partially because of the assumptions that were employed in their calculation. Travel costs were calculated for patients and visitors. Given the assumption that each visitor would make one round trip per patient day, travel costs increased roughly fourfold relative to calculations for patients only. Therefore this assumption, coupled with the distances involved in the initial examples, resulted in high travel cost estimates. In light of this discussion, the travel cost estimates would represent upper bound estimates of the resources that actually would be expended.

Furthermore, the results presented in this chapter assumed that a price elasticity estimate of .07 is an appropriate reflection of decisions of fully informed consumers. The violation of this assumption means that the use of this price elasticity biases the net benefit estimates of the initial hospital system and the system after the closure, as discussed in Chapter 2. For example, assume that individuals rely heavily on the judgement of their respective physician. This implies that the estimated price elasticity (.07) would reflect the advise of physicians rather than the decisions of fully informed consumers. The price elasticity of fully informed consumers probably would be higher than .07. Nevertheless, the net benefit estimates obtained using the higher price elasticities (.25 and .5) were generally of the same sign but smaller than those presented in this chapter.

One additional source of bias was discussed in Chapter 2. The estimates presented could be biased if the marginal cost estimates used do not accurately reflect the social costs of the provision of rural hospital services. If this were the case, the net benefit estimates of the initial and remaining hospital systems would be larger than the figures presented. For example, assume all net benefit estimates were made using the logarithmic specification, and that the quadratic specification reflected the social costs of provision of hospital services more accurately. (The quadratic net benefit estimates of both systems are much higher than those obtained from the logarithmic specification.) If this were the case, use of the true social cost estimate would significantly decrease the net benefit estimates. However, this method of correcting the bias requires knowledge of the cost function that reflects the social cost of providing hospital services, which is unknown.

A second method of correcting the bias is available. In order to make the correction, direct income of the hospital employees greater than the income they would receive in their next best alternative would be entered as a benefit from the operation of the hospitals. The inclusion of income resulting from the hospital will tend to make the net benefits of the hospitals, before and after the closure, larger but the ultimate effect on the net benefits resulting from the closure is not known since it depends on the relative magnitudes of the income gains to each community. The use of this method would require much additional knowledge to determine the income resulting from the hospital in excess of the opportunity cost of the resources which is difficult to determine in reality.

Chapter 5

POLICY IMPLICATIONS

The previous chapter presented net benefit estimates resulting from the closure of Hospital B for different remaining hospital systems. Example 1 was the realistic case where only one large hospital was affected by the closure. The net benefit estimates suggested the closure would be undesirable when corrected for travel and ambulance costs. The second example assumed the displaced demand would be split equally between two large facilities. The net benefit of the closure estimates were smaller in this example than those obtained in the previous example. The third example assumed that a large and a small hospital provided the displaced demand. The net benefit estimates of the closure were significantly larger than obtained in the first example but the closure still appeared undesirable from a benefit-cost perspective. The closure in the final example affected two small facilities. In this case, the net benefit estimates suggested the closure would be desirable. The different results of these examples provide evidence that the net benefits resulting from a closure are sensitive to the characteristics of the alternative area hospitals.

The sensitivity of the net benefit estimates to the hospital system result from a number of factors. First, the demand for each facility after the closure and the projected price determined the gross benefits of each of the remaining hospitals. The gross benefits of each hospital increased relative to their initial value due to the greater demand. The total costs, or integral of the marginal cost function, of providing the projected service level were subtracted from the gross benefits to estimate the net benefits after the closure. The total cost estimates are dependent on the shape of the marginal cost function and the volume of services consumed after the closure. For example, the quadratic marginal cost function was U-shaped and reaches its minimum value at an occupancy rate of approximately 48 percent. If the closure resulted in occupancy rates of the remaining facilities greater than this value, the additional costs of providing the last unit of services were increasing and the total cost of the hospital increased rapidly. The logarithmic marginal cost function declines throughout and its use yields total cost estimates that increase much slower, as the volume of services increases, than those obtained from the quadratic specification. The total costs of the remaining hospitals were always less than the costs of the initial hospital system when the logarithmic specification was used. The difference in the net benefit estimates obtained using the two different cost functions suggest that the additional costs of providing the displaced demand have an important influence on the net benefits of closing rural hospitals.

The net benefit estimates presented in the previous chapter were calculated for only one year. To conduct a complete cost-benefit analysis, the net benefits that likely would occur in the future need to be estimated and discounted. Nevertheless, factors that would affect the net benefit estimates can be identified and used to predict the future changes in the net benefit estimates without repeating the necessary calculations for each future year. For example, travel costs will change over time due to a number of factors such as increasing fuel costs, increasing time costs, and changes in rural transportation facilities. On net, it is expected that travel costs will increase in the future.

The effects on the net benefit estimates of higher travel costs are two-fold, with both acting to reduce the net benefit estimates over time. First, greater travel costs will in effect increase the "price" of more distant, relatively specialized hospitals implying the utilization of the community's hospital would increase in response to the rising travel costs. Greater utilization of low occupancy hospitals will increase the net benefits of the initial hospital system by 1) increasing the benefits of the facilities, and 2) allowing the hospitals to exploit economies of scale. Furthermore, greater travel costs imply that more resources will be expended by travel as the displaced patients attend other hospitals after the proposed closure. In general, increasing travel costs would decrease the net benefits of closing a rural hospital.

Other factors that imply the net benefits of closures will decrease over time are more comprehensive insurance coverage of rural residents and increasing populations of rural communities. More comprehensive insurance coverage will act to insulate rural residents from price differentials between hospitals. Presumably, this implies that the utilization of small rural hospitals may increase in response to the greater insurance coverage. The price differential to consumers of efficient and inefficient hospitals will be reduced suggesting that rural residents would increase their use of the less efficient rural hospitals. Moreover, more comprehensive insurance coverage implies that rural residents will become more responsive to travel costs in their selection of hospitals which would act to increase the utilization of the community hospital.

Population change also can affect the utilization of the community hospital. It is expected that the utilization of rural hospitals is positively correlated with the population change of the community, with increasing community populations resulting in increased utilization of the community hospital. In light of discussions on the "rural-urban turnaround," the net benefits of the community hospital will increase in communities that will likely experience prolonged population growth over time. Simularly, the net benefits of the community hospital will decrease in communities with declining populations.

Rapid increases in health care technology have reduced the average length of stay through time. If this trend continues into the future, the utilization of the nation's hospitals will decline ceteris paribus, implying that the net benefits of a closure would increase due to this effect. The decline in the utilization suggests that greater cost savings will accrue through the consolidation of hospital services.

The proceeding discussion identified factors that would affect the net benefits of a closure over time. Many of the factors will affect all of the nation's hospitals and are not isolated to a particular area. However, the population change experienced by communities will vary among geographical subdivisions of the nation and therefore, will alter the net benefits of closing a specific hospital through time. The projected population of a community can have the largest effect on the desirability of the closure of its hospital but the other factors identified need be kept in mind when addressing the temporal distribution of net benefits.

The distribution of benefits and costs resulting from a closure has important implications in regard to the politics of strategies to reduce rural hospital capacity. The first example presented in the previous chapter will be examined to illustrate the distributional impacts of the closure as discussed in Chapter 2. The closure of Hospital B in the first example resulted in a price decrease to consumers of Hospital A ranging from \$2.90 to \$9.74 per patient day for the logarithmic and quadratic cost specifications, respectively. Due to the reduction in the price of hospital services, the original consumers of Hospital A are made better-off (as measured by increases in consumer surplus) by between \$75,467 and \$254,958 depending on the cost specification. Moreover, Community A would further benefit from the closure of Hospital B as the displaced patients and visitors redistribute a portion of their spending to Community A. The increased spending for goods and services would tend to increase the income and long-run viability of Community A.

Community B, however, bears much of the costs of the closure. The price of hospital services per patient day to consumers after the closure increases approximately \$3 when the logarithmic cost function is used and decreases roughly \$3.60 under the quadratic specification. The estimated price differences after the closure yields changes in consumer surplus of \$-14,699 and \$17,649 for the logarithmic and quadratic cost specifications, respectively. Furthermore, individuals from Community B will have to travel to consume hospital care which makes them relatively worse-off due to the closure of their hospital. The travel cost estimates presented in the example illustrate the magnitude of this component of the costs resulting from the closure of Hospital B (Table 4-2). In addition to the above mentioned costs, the closure of Hospital B will place individuals from the community in a position of greater risk of morbidity and mortality. Estimates of the community's willingness to pay to avoid the additional risk were not undertaken in this analysis but it is expected that risk is an important component of arguments against a rural hospital closure.

Throughout the analysis, it was assumed displaced employees of Hospital B would be re-employed in activities where their contributions are of equal social value. However, this does not preclude Community B from experiencing a direct loss of income from the closure because some of the individuals may migrate from the community. The actual loss of income that would result depends on the community's and the individual's reactions to the closure. At one extreme, all of the displaced workers could migrate from the community which would result in the largest loss in community income. In this extreme case, the short-run income loss would include the payroll of the hospital and indirect losses to other individuals as community spending is decreased. The payroll of Hospital B was roughly $500,000 in the year under investigation and provides an estimate of the direct loss of income in this example. Average community income multipliers were estimated to range from 1.09 to 1.63 (Christianson and Faulkner, p. 14). These multipliers were used to estimate the total short-run loss of community income resulting from the closure. The estimated lost income to Community B under this scenario ranged from $545,000 to $815,000 depending on the value of the multiplier. However, these estimates provide an extreme example of the income losses resulting from the closure. Another equally extreme scenerio can be developed that would result in no direct loss of community income. This would occur if all of the displaced workers were re-employed within the community in activities of equal social value. Indirect income losses would occur, even under this scenerio as community spending is redistributed to Community A. This scenario may be unrealistic in many rural communities that experience low levels of economic development implying some direct losses of income would result from the closure of rural hospitals. The actual loss will depend on the community and the reaction of the affected individuals.

Other entities will benefit from reorganization of rural health care delivery systems. These groups are the third party payers of the medical bills. In the first example, the total costs of providing hospital services to the area decrease as a result of the closure of Hospital B. This implies that the payments made by third parties also will decrease (assuming average cost pricing). To illustrate the gainers and the magnitude of the gains, it will be assumed that 49 percent of the billings are paid by the Federal government through medicare and medicaid and 35 percent are paid by private insurance companies (Christianson and Faulkner, Table 1). These percentages and the results from example 1 suggests the Federal government will save $192,181 to $708,787 in insurance liabilities from the closure, for the logarithmic and quadratic specifications, respectively.

Private insurers would save between $137,273 and $506,277 for the logarithmic and quadratic specification, respectively. These estimates suggest that third party payers could be expected to support the closure in this example.

The distribution of benefits and costs resulting from the closure of Hospital B in the first example presented were investigated. These distributional impacts suggest that Community A unambiguously would benefit from the closure of its neighboring hospital through the price reduction and increases in community income. Similarly, the Federal government and private insurance companies also would benefit from the closure due to the reduction in their payments. Ultimately, individuals covered by private insurance could benefit as their medical insurance premiums are adjusted to reflect the savings to the companies. However, Community B bears much of the cost of the closure and is made relatively worse-off which suggests the community would oppose any attempt to close their hospital.

The "planning approach", as discussed in Chapter 2 was used to estimate the benefits resulting from the closure of Hospital B in the examples presented. The calculated benefits obtained from the planning model were compared with the net benefit estimates obtained using the economic model to ascertain if there were any significant differences (Table 5-1). The results of the planning approach are quite different and more inconsistent than the estimates made using the economic model.

Table 5-1

COMPARISON OF NET BENEFIT ESTIMATES
OBTAINED FROM THE PLANNING MODEL & ECONOMIC MODEL

Example	Demand Estimate	Specification of the Cost Function: Log: Planning *	Log: Economic	Quadratic: Planning	Quadratic: Economic
		--dollars--			
I	High	437,371.9	417,171.8	-273,135.7	-400,677.4
	Low	515,233.3	253,209.4	-139,115.1	-506,383.8
II	High	425,638.3	395,374.3	-185,524.8	-410,629.6
	Low	505,619.2	238,889.3	-69,329.8	-526,389.4
III	High	452,316.9	434,537.7	78,908.6	-71,414.4
	Low	528,123.7	269,455.7	146,198.3	-220,940.2
IV	High	478,995.4	473,701.0	298,174.0	267,800.8
	Low	550,365.5	300,022.0	361,725.3	84,509.0

* High demand simple addition of previous patient day. Low demand assumed a 10 percent decrease in the initial patient days consumed by Community B. (The same patient allocations were used as in the previous examples.)

Furthermore, the differences are more profound for the low demand estimates with the planning approach consistently yielding greater benefits for the low demand estimates than those obtained from the high demand estimates. The differences in these results makes the closure appear more desirable when the planning approach is used over the economic approach.

A cost-benefit framework for evaluating the desirability of rural hospital closures was developed and applied to four hypothetical examples in this thesis. The framework illustrates that the methodology