THE DEMAND FOR HOSPITAL SERVICES

By

PAUL HERBERT ENGELMANN

Bachelor of Arts
Drury College
Springfield, Missouri
1967

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1973

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
May, 1976

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Thesis Approved:

Joseph M. Jadlow
Thesis Adviser

Gerald M Lage

Stephen J Miller

Joseph J Klos

N N Durham
Dean of the Graduate College

PREFACE

The use of third-party payments to finance health care is pervasive throughout the United States. There increasingly is talk of some form of a national health plan. No study has been conducted to test the effects of differing rates of return, or payback ratios, of health insurance policies on the demand for hospital services. It is the purpose of this study to make such a test. The methodology employed uses multiple regression analysis to test for statistical significance and double-logarithmic regressions to estimate the respective demand elasticities.

I wish to acknowledge the many people who have been important to this study and to my graduate education. I am very grateful to the members of my advisory committee. Professor Gerald Lage provided extremely valuable help in the earliest stages in clearly formulating the hypothesis. Professors Joseph Klos and Stephen Miller gave helpful suggestions in the later stages of the study. The chairman of the committee, Professor Joseph Jadlow, provided invaluable assistance through his encouragement, interest, and prompt and knowledgeable guidance.

In addition, I would like to thank all of the faculty of the Department of Economics for making my graduate education a rewarding and stimulating experience. Special thanks go to Professors Richard Leftwich, Frank Steindl, and Michael Edgmand.

I would also like to thank Robert Crosslin, who made available to me the basic data on health insurance policies and suggested the topic as a possibility. Further thanks go to Sharon Hair for typing the final copy.

Finally, I would like to thank my family. To my parents, Herbert and Elsa Engelmann, whose heritage, sacrifice, understanding, and constant encouragement made all of my education possible go my deepest thanks. To my wife, Sue, and daughter, Stacy, go thanks for the encouragement and optimism they have provided and for the source of inspiration they have been in the completion of this study.

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CHAPTER I

INTRODUCTION

The health insurance industry within the United States has recently received increasing attention in the Congress. Since the late 1960's numerous legislative proposals to establish a program of national health insurance have been made. These include programs of mandatory insurance by employers through private insurance carriers, health insurance programs financed and administered either totally or partially by the federal government, and programs calling for the federal government to pay, on a progressive basis, a portion of the private health insurance premiums of the populace.[1]

State legislatures are also becoming more involved in health insurance. California, following the recommendation of former HEW Secretary John Gardner, recently issued minimum standards of coverage (benefits) which must be included in any health insurance policy sold in that state.[2] This type of action has since been repeated in other states.

The impetus behind these legislative proposals and actions is the increasing cost of hospital care, both in dollar terms and as a

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[1]"National Health Insurance Proposals Pending in the 93rd Congress," The Congressional Digest, LIII (June-July, 1974), p. 168.

[2]"California Issues Minimum Standards for Health Insurance," Modern Hospital, CXIX (December, 1972), p. 42.

percentage of Gross National Product. The consumer price index shows a 69.8 percent increase in the price of medical care for July, 1975 over the base year of 1967 as compared with a 62.3 percent average increase for all items.[3] As a percentage of Gross National Product, hospital expenditures have risen from .631 percent of GNP in 1929 to 1.299 percent in 1950 to 2.927 percent in 1974.[4]

While these costs have been rising, growing numbers of people have turned to private groups to finance these costs through some form of insurance. The Office of Research and Statistics of the Social Security Administration estimates that 78 percent of the populace under 65 had hospital care insurance in 1973, as opposed to only 72.3 percent in 1962.[5] (The Health Insurance Association of America, which traditionally has higher estimates, arrived at a 90.9 percent figure for 1973.[6]) These insurance policies are written by several groups. For those under 65, Blue Cross - Blue Shield has 36.2 percent of all policies; private insurance companies' group policies account for 37.1 percent; private insurance companies' individual policies account for 22.6 percent; and independent plans write 4.1 percent of all policies.

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[3] U. S. Department of Commerce, Survey of Current Business, LV (August, 1975), p. S-8.

[4] Data on GNP was obtained from the Federal Reserve Bulletin, LXI (May, 1975), p. A-54. Data on total hospital care expenditures are from Nancy L. Worthington, "National Health Expenditures, 1929-1974," Social Security Bulletin, XXXVIII (February, 1975), p. 13.

[5] Marjorie Smith Mueller, "Private Health Insurance in 1973: A Review of Coverage, Enrollment, and Financial Experience," Social Security Bulletin, XXXVIII (February, 1975), p. 27.

[6] Ibid., p. 24.

Insurance companies are required, by law, to keep information regarding benefit expenditures and premium income for each type of plan. The ratio of benefit expenditures to premium income is referred to by those in the insurance industry as a "loss ratio," in that it indicates the amount of each dollar received in the form of premiums which is "lost" to the company as a benefit paid out to policyholders.[7] However, it would seem that a more appropriate term would be "payback ratio," since, to that group of policyholders, it indicates how much of a dollar in premiums is "paid back" in the form of benefits. Hence, the term "payback ratio" is used throughout this dissertation.

The variation in payback ratios by type of plan is substantial. Table I shows the payback ratios on various types of existing insurance plans in 1971 for the United States as a whole.

The decision to enter the hospital is not really different from the decision to purchase any other good or service. The individual simply considers the effective cost (price) of entering the hospital vis-à-vis the prices of other goods and services and, given his utility function at that point in time, arrives at a conclusion. If hospital care were a "free good," an individual would consider solely his state of health in his decision on whether or not to enter the hospital. Economic factors would play no role at all; that is, the values of these economic variables would not be statistically different from zero as determinants of the demand for hospital services.[8] In fact, several

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[7]Mark R. Greene, Risk and Insurance (Cincinnati, Ohio, 1968), pp. 141-142.

[8]This, of course, assumes no multicollinearity between economic variables and those affecting one's level of health, as well as a correct specification of the model.

authorities have suggested that the price of hospital services is unimportant in this decision-making process. Klarman interprets a study by Paul J. Feldstein and Ruth M. Severson as demonstrating perfect price inelasticity of demand.[9] Others suggest that price and income do affect medical expenditures.[10]

TABLE I

PAYBACK RATIOS ON VOLUNTARY HEALTH INSURANCE, 1971
(Dollar Amounts in Millions)

Type of Plan	Benefits Received*	Premiums Paid*	Payback Ratio
Blue Cross - Blue Shield	$8,178.7	$8,790.2	.9304
Private Insurance Companies			
Group Policies	7,408.0	7,724.0	.9591
Individual Policies	1,111.0	2,038.0	.5451
Independent Plans			
Community	508.0	536.6	.9467
Employer-Employee-Union	611.0	638.5	.9569
Private Group Clinic	14.4	17.8	.8090
Dental Society	60.0	75.0	.8000

*Source: Marjorie Smith Mueller, "Private Health Insurance in 1971: Services, Enrollment, and Finances," Social Security Bulletin, XXXVI (February, 1973), p. 15.

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[9]Herbert E. Klarman, The Economics of Health (New York, 1965), p. 25.

[10]Kenneth J. Arrow, "Uncertainty and the Welfare Economics of Medical Care," American Economic Review, LIII (December, 1963), p. 950.

Before any of the proposed legislation is acted upon, it would be beneficial to know to what extent economic factors affect the demand for hospital services. Several of the plans would involve compulsory health insurance furnished either by the employer or the government. It is plausible that in either situation the payback ratio would be affected, as these plans effectively eliminate certain barriers (such as cost or failure to belong to a group which has a group health insurance policy) which currently deprive certain people from obtaining health insurance policies with relatively high payback ratios (essentially group policies).[11] Therefore, in order to estimate accurately the change in demand, one must know the effect the payback ratio and other factors have on the demand for hospital services. It is the purpose of this dissertation to ascertain the magnitudes of these effects.

Chapter II reviews past attempts to analyze the demand for hospital services. It illustrates, both graphically and mathematically, how differing payback ratios can be expected to lead to differing quantities demanded of hospital services.

Chapter III presents the theoretical model used in the empirical analysis. Justification of the included independent and dependent variables is given.

Chapter IV discusses econometric problems encountered in the study. The empirical results obtained through multiple regression analysis are

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[11]For example, Somers and Somers found that the share of the premium dollar retained by the insurance company within group policies varied from 30.6¢ for groups of 100 people to 5.5¢ for groups of 10,000 people. See Herman Somers and Anne R. Somers, Doctors, Patients, and Health Insurance (Washington, D.C., 1961), p. 270.

presented and analyzed for both inpatient and outpatient demand. The payback ratio is found to be statistically different from zero. Chapter V summarizes the entire study.

The empirical findings of this study generally support the hypothesis that higher payback ratios, working through both price and income effects, are associated with higher levels of demand for hospital services. It also concludes that outpatient demand reacts more significantly with economic variables than does inpatient demand.

CHAPTER II

THE THEORETICAL FRAMEWORK FOR THE STUDY

Introduction

This chapter deals with past attempts to measure the demand for hospital services. Specific variables included in these earlier studies are examined and shortcomings of these studies are discussed. Then a theoretical justification for the inclusion of the payback ratio as an independent variable is developed graphically and mathematically.

The survey of the literature in this chapter is not intended to be exhaustive. Instead, those studies are presented which illustrate techniques of measurement, dependent and independent variables, and models relevant to this study. A more complete listing of past attempts to measure the demand for hospital services is found in the bibliography.

Examination of the Literature

Numerous researchers have attempted to specify and estimate models of the demand for health services. This section considers a selected few of these prior attempts.

Martin S. Feldstein in his doctoral dissertation at Oxford University[1] studied the British National Health Service. In his study,

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[1]Martin S. Feldstein, <u>Economic Analysis for Health Service Efficiency</u> (Amsterdam, 1967).

using 1962 data from hospitals in the area surrounding Oxford, he analyzed the determinants of hospital admissions and length of stay. The study was limited to maternity cases.[2] He found that the decision to enter the hospital was determined by age, number of previous children, past obstetric history, social class, availability of beds, and marital status.[3] Feldstein reported no regression coefficients, instead reporting only the percentage deviation in admission probabilty for each regression.[4] As the entire population of his study was covered by the National Health Service, he did not include economic variables (price, income) in his analysis. Hence, the importance of Feldstein's study is its use of admissions as a measure of quantity demanded.

Paul J. Feldstein and W. John Carr examined the effect of income on medical care spending by the private sector of the economy.[5] Ten sets of data were used in a cross-section analysis ranging from 1917-1919 to 1960-1961. They began by running simple regressions of medical care expenditures on family income. However, they used only the means of each of the ten data sets. Using double-logarithmic regressions, the income elasticities ranged from 0.496 (1941) to 0.957 (1935-36). The most recent data (1960) yielded an income elasticity of 0.683.[6]

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[2]Ibid., p. 241.

[3]Ibid.

[4]Ibid., p. 244.

[5]Paul J. Feldstein and W. John Carr, "The Effect of Income on Medical Care Spending," American Statistical Association: Proceedings of the Social Science Section (1964), pp. 93-105.

[6]Ibid., p. 95.

However, they felt additional regressors that were left out might have biased upward the elasticity estimate. Therefore they next included family size, age of head of family, education of head of family, number of family members gainfully employed, insurance expenditures, and percent of families insured.[7] Further, in order to eliminate the effects of transitory income and more closely approximate permanent income, they grouped the data by city, believing that the transitory components might average out to zero for each city. Income elasticity estimates were 1.065 for 1950[8] and 0.433 for 1960.[9] No price elasticities were computed.

It is noteworthy that the Feldstein and Carr study included health insurance expenditures in the second series of regressions. They apparently reasoned implicitly that this would be a suitable proxy for coverage, which is in reality the desired variable. Yet, if significant differences in payback ratios occur, this would be a false assumption.

In one of the most frequently cited studies, Paul J. Feldstein and Ruth M. Severson[10] used cross-section analysis employing multiple regression on data collected by the Health Information Foundation and the National Opinion Research Center, University of Chicago. These data were collected across the United States civilian non-institutional

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[7]Ibid., pp. 99-100.

[8]Ibid., p. 99.

[9]Ibid., p. 100.

[10]Paul J. Feldstein and Ruth M. Severson, "The Demand for Medical Care," Report of the Commission on the Cost of Medical Care, Vol. I (Chicago: American Medical Association, 1964), pp. 57-76.

population in July, 1953 and the summer, 1958. Information collected included the amount spent on medical care, extent of insurance coverage, age, urbanization, family size and family type, and income.

The study estimated the price elasticity of demand for physician visits at -0.19; that for gross physician expenditures at 0.02; and that for hospital admissions at 0.11.[11] Toerber, however, reports that this is not consistent with experience under the Medicare program where it has been found that hospital utilization by those eligible to receive free hospitalization increased 23 percent.[12] Feldstein and Severson later note that "... a 10 percent increase in the proportion of the bill paid by insurance would lead to an increase of 4.8 percent in hospital expenditures, 4.5 percent in hospital admissions, and 2.5 percent in patient days."[13] In addition, they noted that these results are probably biased downwards.[14]

In 1970 Hyman Joseph utilized cross-section data to determine the effects of third-party payment on length of stay in hospitals for 22 separate illnesses or conditions.[15] The study was conducted to test a

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[11]Ibid., pp. 66-67.

[12]Garry A. Toerber, <u>An Evaluative Analysis of Medical Care Financing Systems with Particular Emphasis on a National Health Insurance</u>, Graduate Program in Hospital and Health Administration, Health Care Research Series No. 20 (Iowa City, Iowa: University of Iowa, 1972), p. 63.

[13]Paul J. Feldstein and Ruth M. Severson, p. 67.

[14]In estimating the price variable, Feldstein and Severson used an average unit price for all families when no other price variable could be found.

[15]Hyman Joseph, "Hospital Insurance and Moral Hazard," <u>Journal of Human Resources</u>, VII (Spring, 1972), pp. 152-161.

phenomenon called "moral hazard." In insurance literature, moral hazard is an increase in usage of hospital services as a result of the lowering of hospital costs to the user through insurance. Mark V. Pauly[16] has argued that this phenomenon depends upon rational economic behavior and the presence of a nonzero price elasticity of demand.[17] In the study Joseph found the price elasticities of demand to be "generally low," with estimates of more than one (i.e., elastic demand) in only two of the 22 categories. Joseph felt, however, that the price elasticity estimates were biased downwards due to the method of recording the data used in the study.[18]

Karen Davis and Louise Russell studied the demand for outpatient care and the substitutability of outpatient care for inpatient care.[19] They used a multiplicative model with statewide data for their regressions. The data on visits was taken from the 1970 Guide Issue of Hospitals. Inpatient price was measured by (1) inpatient revenue per patient day, (2) inpatient revenue per admission, and (3) the basic charge for a two-bed room.[20] In addition, they measured the effect

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[16]Mark V. Pauly, "The Economics of Moral Hazard: Comment," American Economic Review, LVIII (June, 1968), pp. 531-537.

[17]It should be obvious that if hospital usage were determined solely by medical factors, then the price elasticity of demand for hospital services would be zero.

[18]Hyman Joseph, p. 160.

[19]Karen Davis and Louise B. Russell, "The Substitution of Hospital Outpatient Care for Inpatient Care," Review of Economics and Statistics, LIV (May, 1972), pp. 109-120.

[20]Ibid., p. 112.

of the price of hospital outpatient care on inpatient demand. Inpatient demand was measured by admissions and length of stay. In this study they found that the outpatient price variable was significant at the 0.01 level with an elasticity of 0.25. They further found that the cross elasticity of inpatient price with respect to outpatient care is four times as high as that for outpatient price with respect to inpatient care. This simply means that a percentage change in the price of inpatient care has a greater effect on outpatient visits than the same percentage change in the cost of outpatient care has on inpatient admissions.[21]

Of further note is the effect of inpatient price and income on inpatient demand. When inpatient price is measured by inpatient revenue per patient day, the results are not statistically significant. However, when inpatient price is measured by inpatient revenue per admission, the variable is significant at the 0.01 level and has an elasticity of -0.32. They also found that the signs associated with the insurance variable were positive, indicating an increase in insurance coverage leads to an increase in hospital admissions. The reported R^2's ranged from .72 to .80.[22]

The final studies to be considered are those conducted by Gerald D. Rosenthal. In the first of these Rosenthal hypothesized that the demand for hospital services (measured by patient days per 1000 population, admissions per 1000 population, and average length of stay)[23]

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[21]Ibid., p. 115.

[22]Ibid.

[23]Gerald D. Rosenthal, The Demand for General Hospital Facilities (Chicago, 1964), p. 34.

was a function of price, income, insurance coverage, age, marital status, sex, urbanization, education, race, and family size. Price was measured by the mean charge for a two-bed room. Units of observation were the individual states. Rosenthal tested both an additive model and a multiplicative model in his analysis using least-squares multiple regression. R^2's of from 0.5473 to 0.7971 (corrected R^2's of from 0.3742 to 0.7195) were obtained from the additive model.[24] The multiplicative model yielded R^2's of from 0.4826 to 0.7643 (corrected R^2's of from 0.2847 to 0.6742).[25] Rosenthal found the price variable to be significant at the 0.1 level for the 1950 data and significant at the 0.05 level for the 1960 data.[26] All tests were made using a one-tailed t-test. Negative signs were associated with the price regression coefficient. With respect to the two income variables, although a positive sign was obtained in eleven of the twelve opportunities, only three of the eleven were statistically significant at the 0.05 level.[27] The insurance coverage variable showed the correct sign and was statistically significant at the 0.05 level for the 1960 data. However, for 1950 the coefficients had the proper sign in only two of the three runs, and neither was statistically significant at the 0.05 level. Rosenthal attributed this to a broadening of

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[24]Ibid., p. 35.

[25]Ibid., p. 95.

[26]Ibid., p. 40.

[27]Ibid., p. 35.

insurance scope and coverage in the intervening decade.[28] When comparing the 1950 data to that of 1960, Rosenthal concluded that "the impact of economic variables on utilization of hospital services was such that the role of consumer choice was significantly greater in 1960 than it had been in 1950."[29]

The other Rosenthal study was conducted with data gathered in the New England area.[30] By taking data on 1,112,058 admissions in 68 hospitals for 1962, he was able to subdivide the individual observations into 28 groups, each homogeneous with respect to age, sex, and diagnosis.[31] The hypothesis tested within each group was that demand was a function of price. Demand was measured by length of stay. Price was measured by (1) cash payments as a percentage of the patient's total bill, and (2) the average room charge. R^2's ranged from 0.0119 to 0.5590. Rosenthal found that average room charge fared better than did cash/total bill, being statistically significant at the 0.05 level in eleven of the 28 groups.[32] Having used a multiplicative model (i.e., double-logarithmic), the coefficients were also elasticity estimates. Using daily room charge as price, elasticity estimates for

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[28]Ibid., p. 41.

[29]Ibid., p. 43.

[30]Gerald Rosenthal, "Price Elasticity of Demand for Short-Term General Hospital Services," in Herbert E. Klarman (ed.), Empirical Studies in Health Economics (Baltimore, 1970), pp. 101-117.

[31]Ibid., p. 105.

[32]Ibid., pp. 110-111.

over half of the categories were over 0.2 and significant at the 0.05 level.[33]

Fuchs criticized this study on several counts.[34] Specifically, Fuchs felt that length of stay was not a sufficient estimate of demand but only one dimension of it. Secondly, Fuchs argued that the two price variables "do not measure price or anything even resembling price ..."[35] Fuchs concluded by arguing for the inclusion of such traditional variables as income, education, etc. in the model.[36]

In summary, admissions was used as a measure of quantity demanded in the M. S. Feldstein, the Davis and Russell, and the first Rosenthal study. Cross-section analysis was frequently used. All of the studies except the one by Martin Feldstein used double-logarithmic models to estimate the demand for hospital services. Further, independent variables such as age, race, sex, income, urbanization, and insurance coverage were generally included in these studies.

A Theoretical Illustration of the Economic Effects of the Payback Ratio

While some research has included insurance coverage as an independent variable in the demand for hospital services, any concept analogous to the payback ratio is absent. This section considers some possible

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[33]Ibid.

[34]Victor R. Fuchs, "Comment," in Herbert E. Klarman (ed.), <u>Empirical Studies in Health Economics</u>, pp. 118-120.

[35]Ibid., p. 119.

[36]Ibid., p. 120.

causes of differences in payback ratios and the effects these differing payback ratios can have on the quantity of hospital services demanded. Four basic situations are analyzed: (1) policies of identical coverages but different costs; (2) policies of identical cost but different coverages; (3) policies of identical cost but different deductible amounts; and (4) policies which pay different percentages of the expenses. Each of these situations is then considered with indifference curves to illustrate how different payback ratios would be expected to be associated with different quantities of hospital services demanded.

The effect of health insurance on the demand for hospital services must be considered, for the ownership of insurance will change the individual's perception of the price of hospital services. The economic effect of hospital insurance is to alter the shape of the line of attainable combinations. Consider Figure 1. Line segment AB represents the line of attainable combinations before any hospital insurance is obtained. The purchase of hospital insurance will have the effect of shifting the line of attainable combinations to a new position, such as EKLM. This assumes: (1) the policy cost the individual amount AE; (2) the first OJ dollars of medical care must be paid for by the patient (i.e., as a deductible); (3) KL (=JV) hospital services are entirely paid by the policy; and (4) beyond point L (or V) all additional hospital care must be paid entirely by the patient; there is no additional reimbursement.

Consider a second policy. It is assumed that the deductibles, coverage, etc. are identical to the first policy. The only difference between the two policies is premium cost, with the second policy having

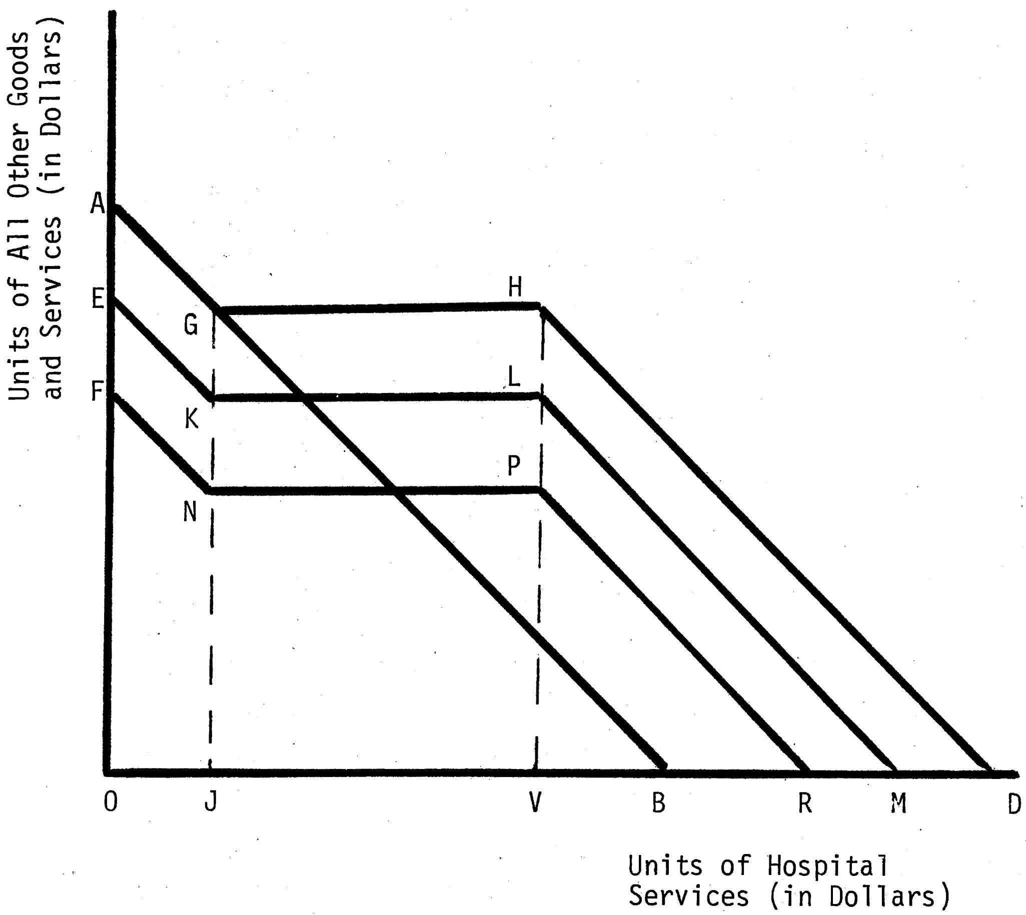

Figure 1. The Effects of Differing Prices on the Line of Attainable Combinations

a cost of AF. Since coverages and deductibles are identical, and for the individual probability of disease does not change with respect to which policy is purchased, it must be concluded that the second policy will have a lower expected payback ratio than did the first policy for that individual, assuming that hospital services are not an inferior good.

Assume a third policy. This policy is furnished at no cost to the individual -- it is a "free good." Assuming the same deductibles and coverages, the line of attainable combinations for this policy will be AGHD.

Now consider the individual as having purchased hospital care so as to exhaust the benefits under any of the three policies (i.e., to have purchased more than OV hospital care). It is now possible to arrive at some conclusions regarding the respective payback ratios. Since the third policy cost the individual nothing, but could pay benefits of JV, the payback ratio for the policy is undefined (but its limit approaches infinity). For policies one and two, it is obvious that they differ only in premium cost. Since expected benefits received are the same, it can therefore be concluded that the first policy had a higher payback ratio than did the second policy inasmuch as the premiums paid were different, but the expected benefits received are identical.

The difference is premium cost is one obvious source of differences in payback ratios. It is not the only source; numerous others exist. Some of the more obvious ones will be illustrated.

Consider two policies that have the same premium cost, same deductibles, same diseases covered, but one policy gives higher dollar benefit limits for each disease or treatment category. This is shown in Figure 2. Line AB is the line of attainable combinations with no insurance purchase. Assume the cost of either policy is AE. The deductible of either policy is OJ. The line of attainable combinations for the policy with the lower benefit limits is EKLM and for the policy with the higher dollar benefit limits is EKST. If any individual were confronted with the purchase of OV hospital services, it is obvious that the payback ratio associated with that policy having line of attainable combinations EKST would be higher than the payback ratio for the other policy (KN/AE versus KL/AE).

Another obvious source of differences in payback ratios is that of differing deductibles. If these policies were identical in cost and coverages (for both dollars and condition or treatment) but one had no deductible while the other required the patient to pay the first X dollars before the insurance company began its benefits, it would be expected that a lower payback ratio would be associated with the latter of these two policies. Consider Figure 3. AB is the original line of attainable combinations; AE is the cost of either policy. Either policy pays a total of ED (= JV = KL) benefits. Note, however, that if only ON hospital services are required to complete a given treatment, then the payback ratio associated with the policy with no deductible would be ED/AE = ON/AE, while that for the policy with OJ deductible would be KM/AE = JN/AE, a lower payback ratio.

In all of the above cases (with the possible exception of Figure 3), the differences in payback ratios are illustrated by parallel shifts of the line of attainable combinations. This is analogous to a change in income; the higher the payback ratio, the larger the change in real

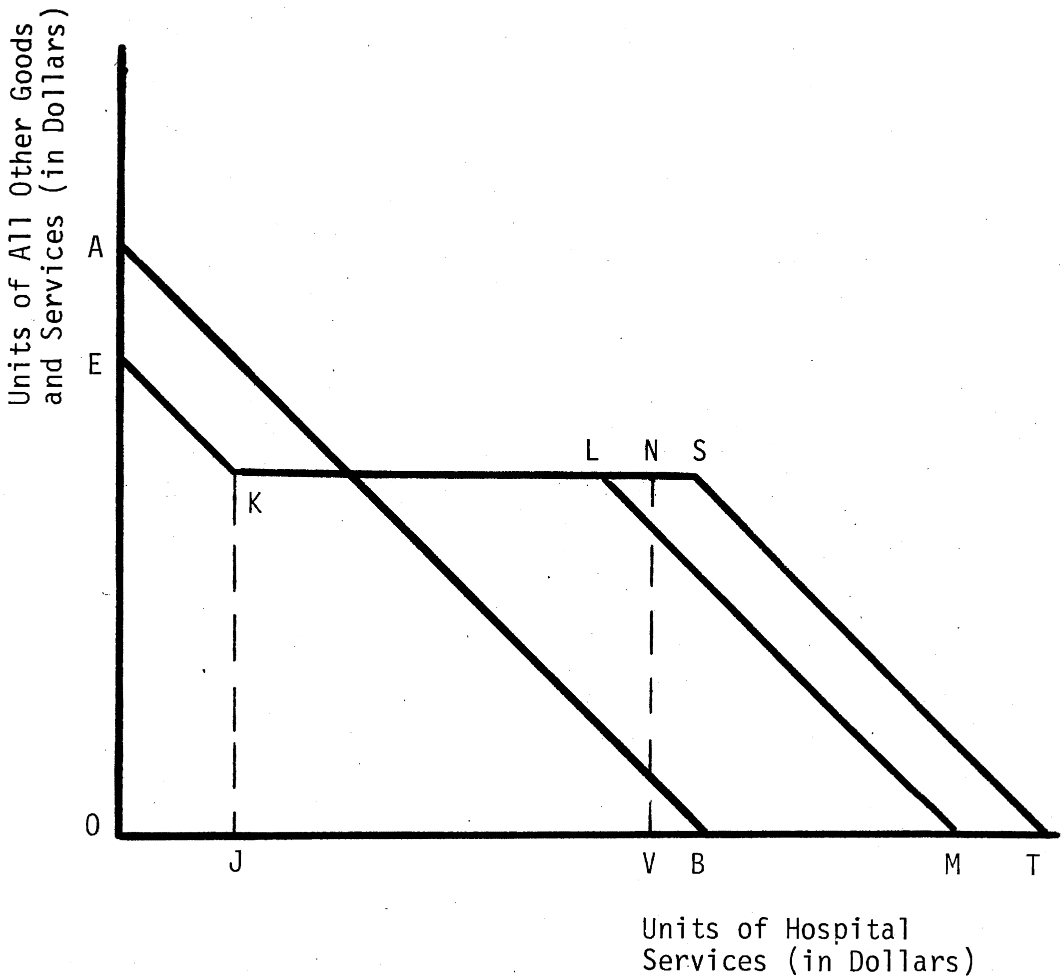

Figure 2. The Effects of Differing Coverages on the Line of Attainable Combinations

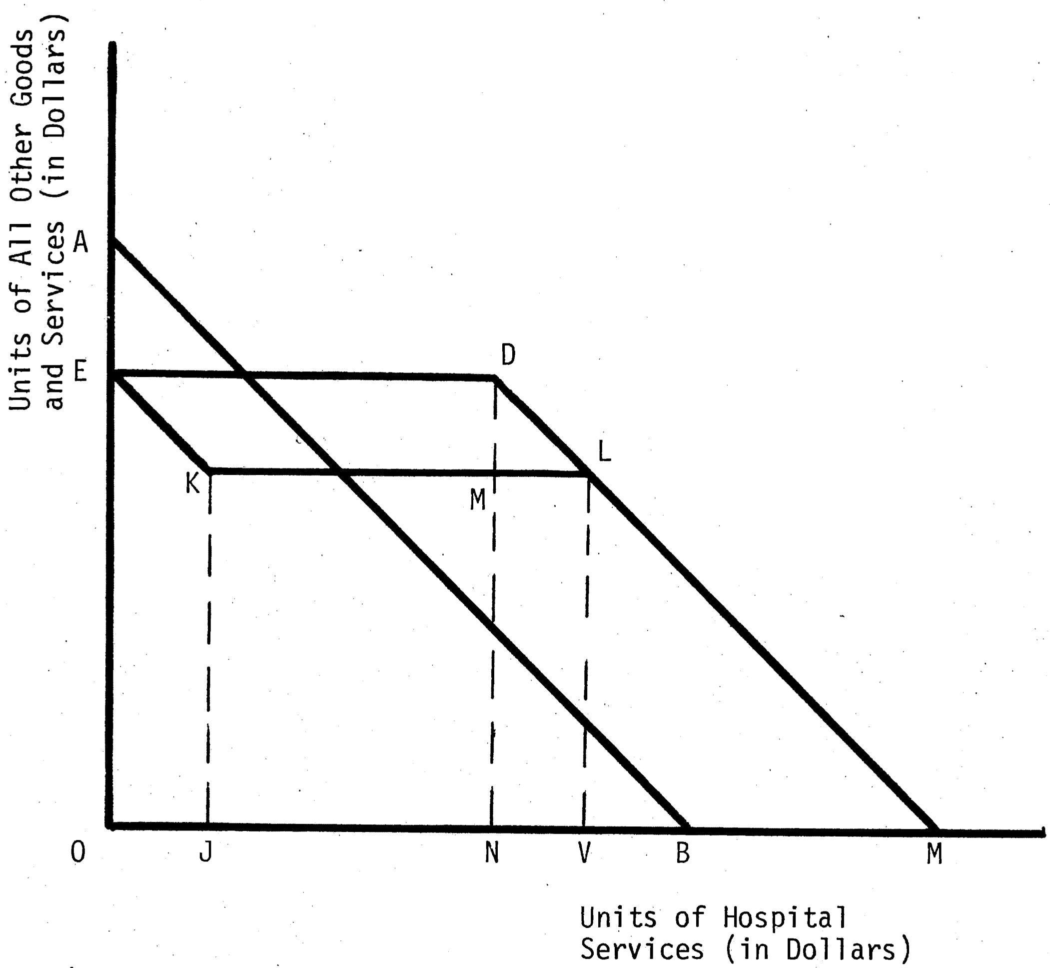

Figure 3. The Effects of Differing Deductibles on the Line of Attainable Combinations

income vis-à-vis a lower payback ratio (and the greater the differences in payback ratios between two policies, the greater the differences in real income, ceteris paribus). Hence, if hospital services are a normal good in the traditional economic sense of the term, it would be expected that larger quantities of hospital services would be purchased given higher payback ratios vis-à-vis lower payback ratios.

But these are not the only sources of variation in payback ratios. Consider two policies of identical costs. Neither policy is assumed to have any deductible associated with it. The first policy yields line of attainable combinations EDM in Figure 4, signifying maximum benefits of ED = OV. The second policy requires the purchaser to pay some portion of the costs of treatment (e.g., 20 percent) but will pay up to a larger dollar amount of hospital services OW, yielding a line of attainable combinations ECM. It is obvious that for any individual purchasing at least OW hospital services the payback ratios of these two policies are the same, since the premium costs of the policies are the same and, beyond C, the lines of attainable combinations are identical. That is, since incomes are the same, the amounts paid for the policies are the same, the quantities of hospital services consumed are the same, and the amount left over for the consumption of all other goods and services (CW) is the same, it must be that the insurance companies paid the same amounts for the hospital services.

Consider a third policy of cost AE, but one which requires the patient to pay a still larger portion of his hospital costs (e.g., 25 percent). The slope of the line of attainable combinations will be steeper (i.e., have a greater negative value) than EC, such as EF.

These are non-parallel shifts of the line of attainable combinations.

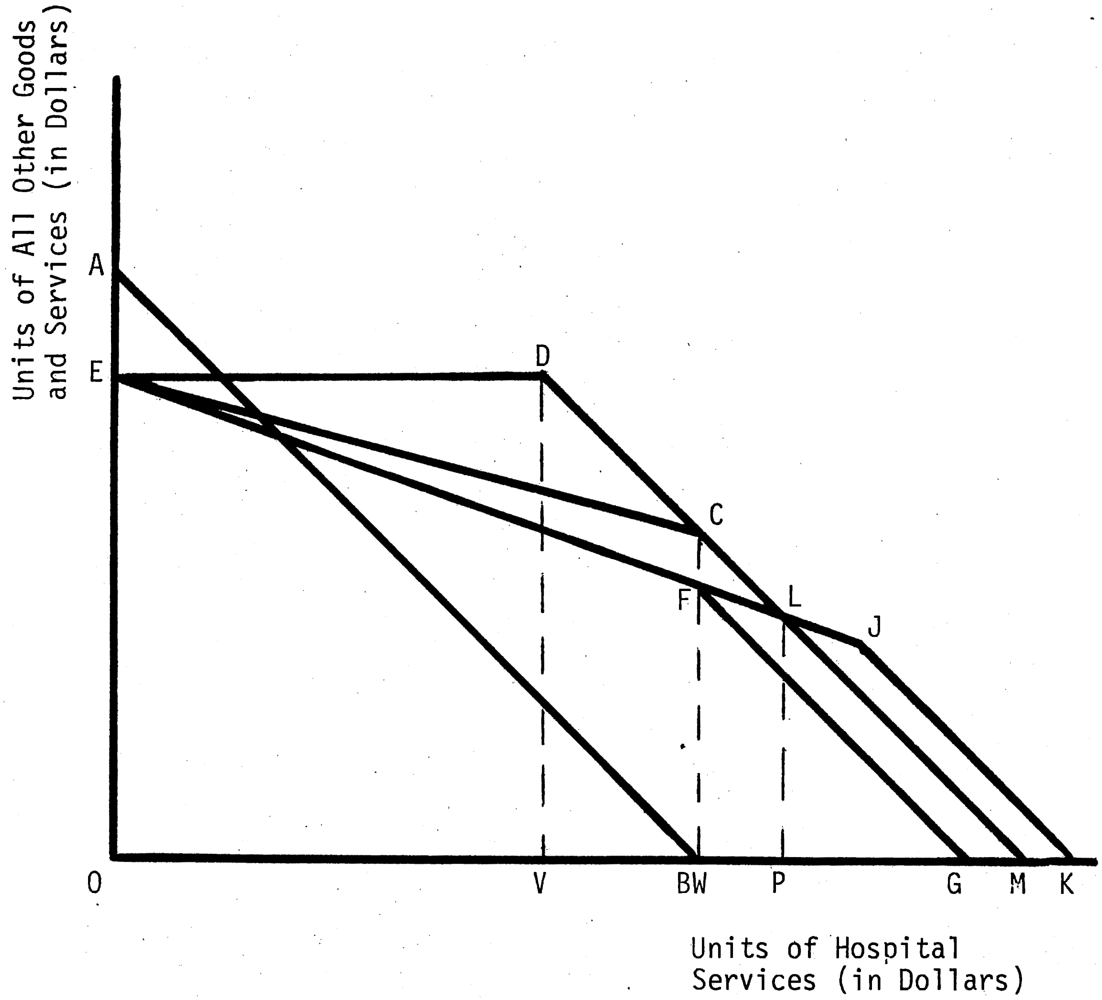

Figure 4. The Effects of Differing Percentage Coverages on the Line of Attainable Combinations

This is a price effect. The steeper slope indicates a higher perceived price for hospital services for the insured. Whether or not the payback ratio is higher, lower, or the same depends on the quantity of hospital services consumed by the patient. For the payback ratio of the third policy to have the potential of being the same or greater, the line of attainable combinations for this third policy would have to extend to or past DM. If the line of attainable combinations is EFG, it can be concluded that the expected payback ratio will necessarily be lower than that of either of the first two policies. If the line of attainable combinations is ELM, and at least OP hospital services are consumed, the expected payback ratios of all these policies are identical; if less than OP hospital services are consumed, the expected payback ratios of the other two policies will exceed the payback ratio of this policy. If more than OP hospital services are consumed, and the line of attainable combinations for this policy is EJK, then this policy will have the highest payback ratio of the three.

In any of these examples, the actual quantity of hospital services consumed by the individual depends upon the tangency of the appropriate indifference curve with the respective line of attainable combinations. The various possibilities will now be considered.

The indifference curves in the following diagrams are based on the assumption that the individual receives no satisfaction from hospital care beyond that which is required for his treatment.[37] It is further

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[37]However, the individual is still willing to trade off some hospital care for other goods and services -- perhaps forgoing the last day in the hospital should it not be covered in the policy (with the consent of his physician), or stay in a semi-private instead of a private room.

assumed that this required level of treatment is finite and known to the physician, given the state of health of the patient. Thus the indifference curves for a given patient with a given condition will all attain a zero slope at the same level of hospital services. However, the indifference curves are not necessarily vertically parallel at quantities less than this amount. Were the indifference curves vertically parallel throughout, this would imply that additional income resulted in no increase in hospital services demanded. Past research shows that this clearly is not the case.

Consider Figure 5. (This is simply Figure 1 with the inclusion of indifferent curves.) Two basic possibilities exist. Should less than OV (say, OW) be the maximum hospital services required for his treatment, the individual will consume exactly the same quantity of services under either policy (shown by the tangencies of indifference curves I and II with the appropriate lines of attainable combinations). In this case, the differing payback ratios cause no change in the quantities of hospital services demanded.[38]

Consider a second (different) situation in which the patient requires more services than the policy provides -- i.e., more than OV services. Again, using normally-shaped (i.e., characterized by a declining marginal rate of substitution) indifference curves (I' and II'), note that now a larger quantity of hospital services is demanded under the policy with a higher payback ratio (OY versus OX), due to

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[38]Should the individual in fact receive positive utility simply from remaining in the hospital past the time required for treatment of his illness or condition, he can consume OV hospital services under either policy and still experience no loss of other goods and services. However, this would require the consent of the admitting physician.

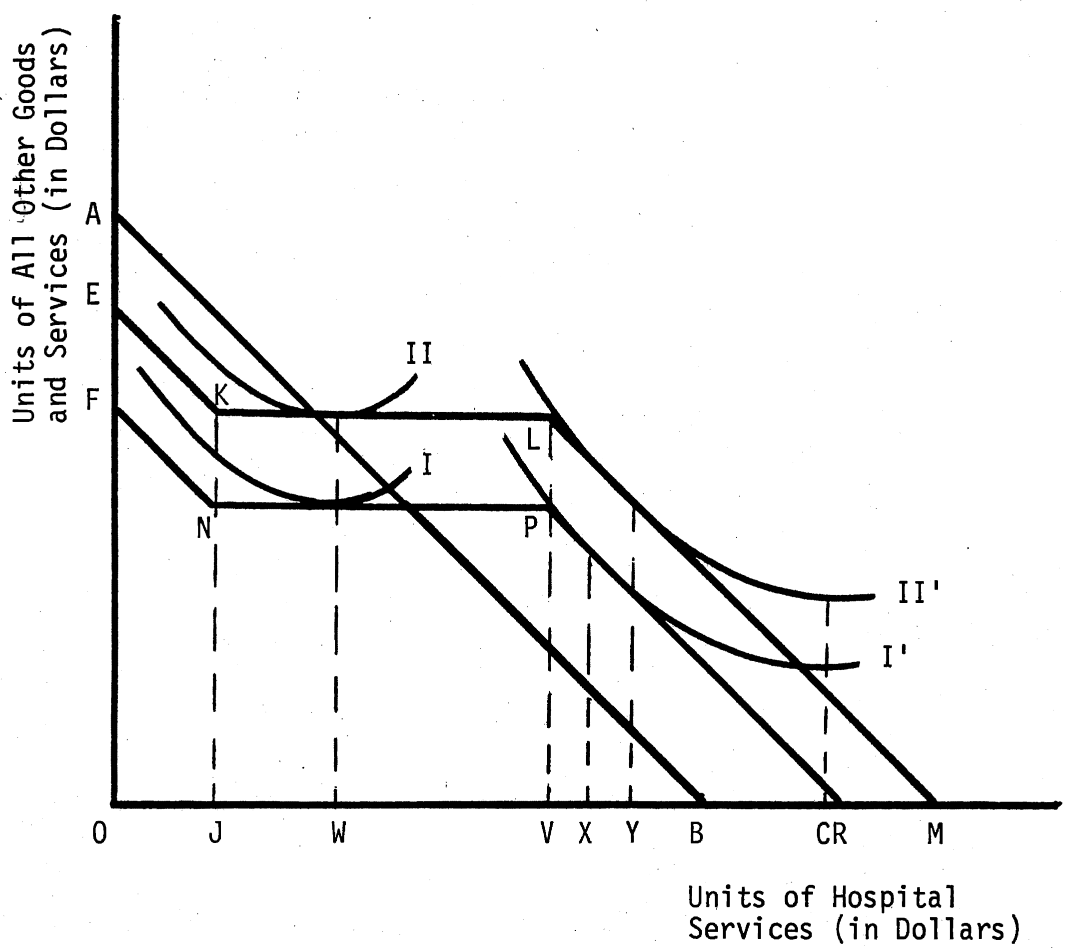

Figure 5. The Effects of Differing Prices on the Purchase of Hospital Services

the greater real income associated with the first policy.[39]

Figure 6 is Figure 2 with the addition of indifference curves. The analysis is the same as in Figure 5. Curve I shows that, when less than OV hospital services are consumed, the policies are virtually identical and hence the same quantity of hospital services (OQ) is consumed. However, if more than OV services are required, the policy with the higher payback ratio (EKST) leads to a larger quantity (OU) of hospital services being consumed than with the other policy (OR).

Figure 7 shows the effects of differing deductibles. The policy with no deductibles (and a higher expected payback ratio), EDM, leads to the consumption of OY hospital services, while the holder of the other policy demands only OX hospital services. Beyond quantity OV, the two policies would yield identical solutions.

The indifference curve analysis for Figure 8, which shows the possibility of price effects, is simplified over the possibilities included in Figure 4. Assume a policy which pays all costs up to OV hospital care, and a second policy which pays only a percentage of those costs but up to a larger amount (OW). If less than OV services are required, it is probable that a larger quantity of hospital services would be chosen under the first policy (OQ versus ON), which would have a higher expected payback ratio at that quantity of hospital services. This is logical. Under the first policy, inasmuch as each additional unit of hospital services is free (out to OV units), it would be expected that a larger quantity of hospital services would be

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[39]Although OC would be consumed were hospital services provided at no charge, the aforementioned trade off between hospital services and all other goods and services now occurs.

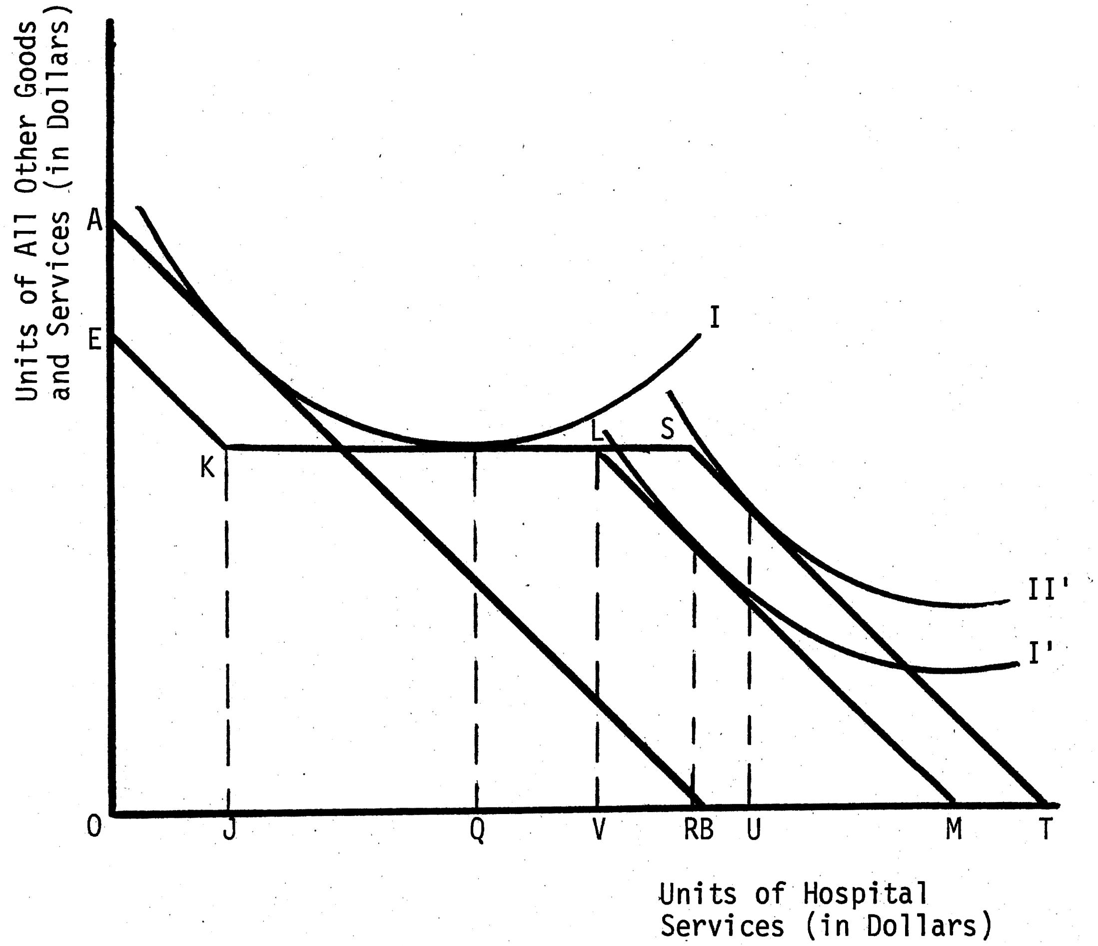

Figure 6. The Effects of Differing Coverages on the Purchase of Hospital Services

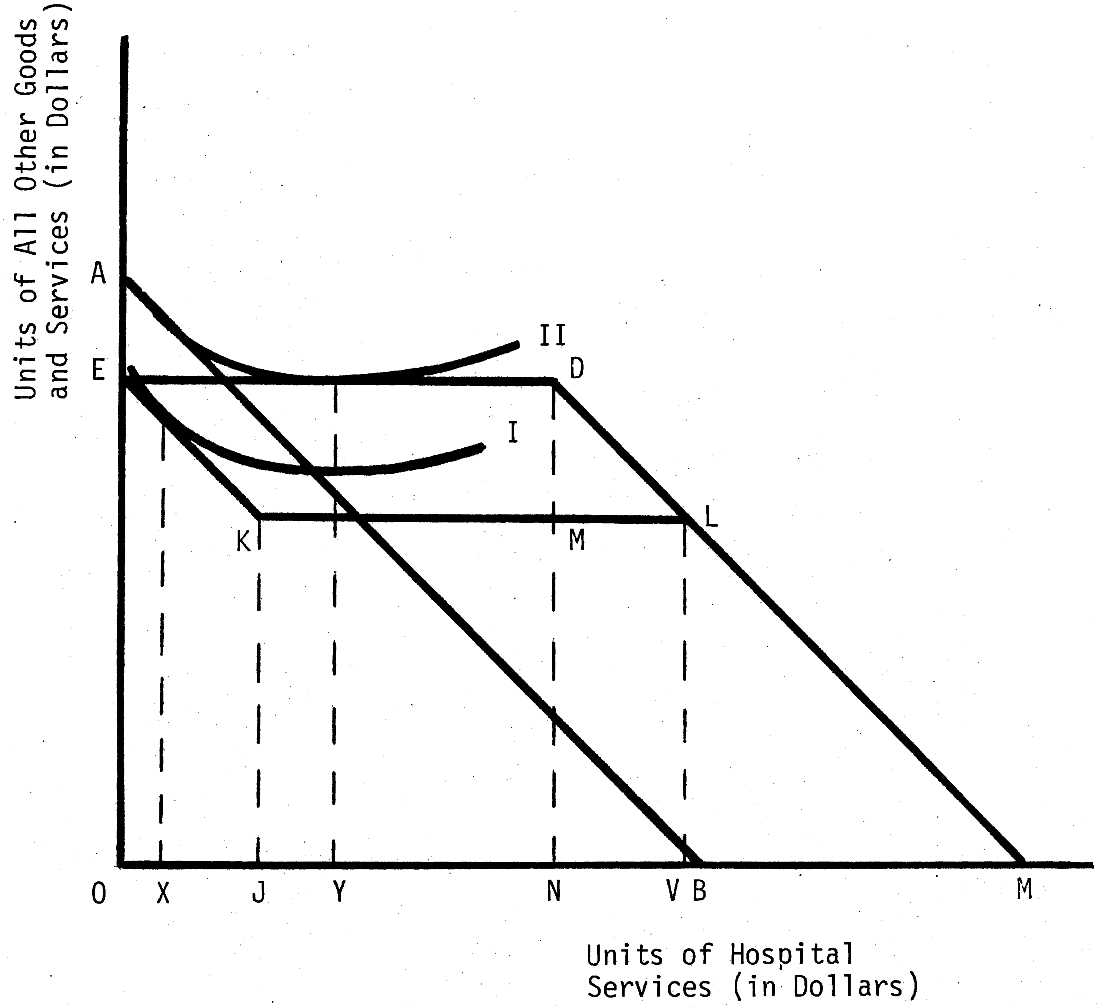

Figure 7. The Effects of Differing Deductibles on the Purchase of Hospital Services

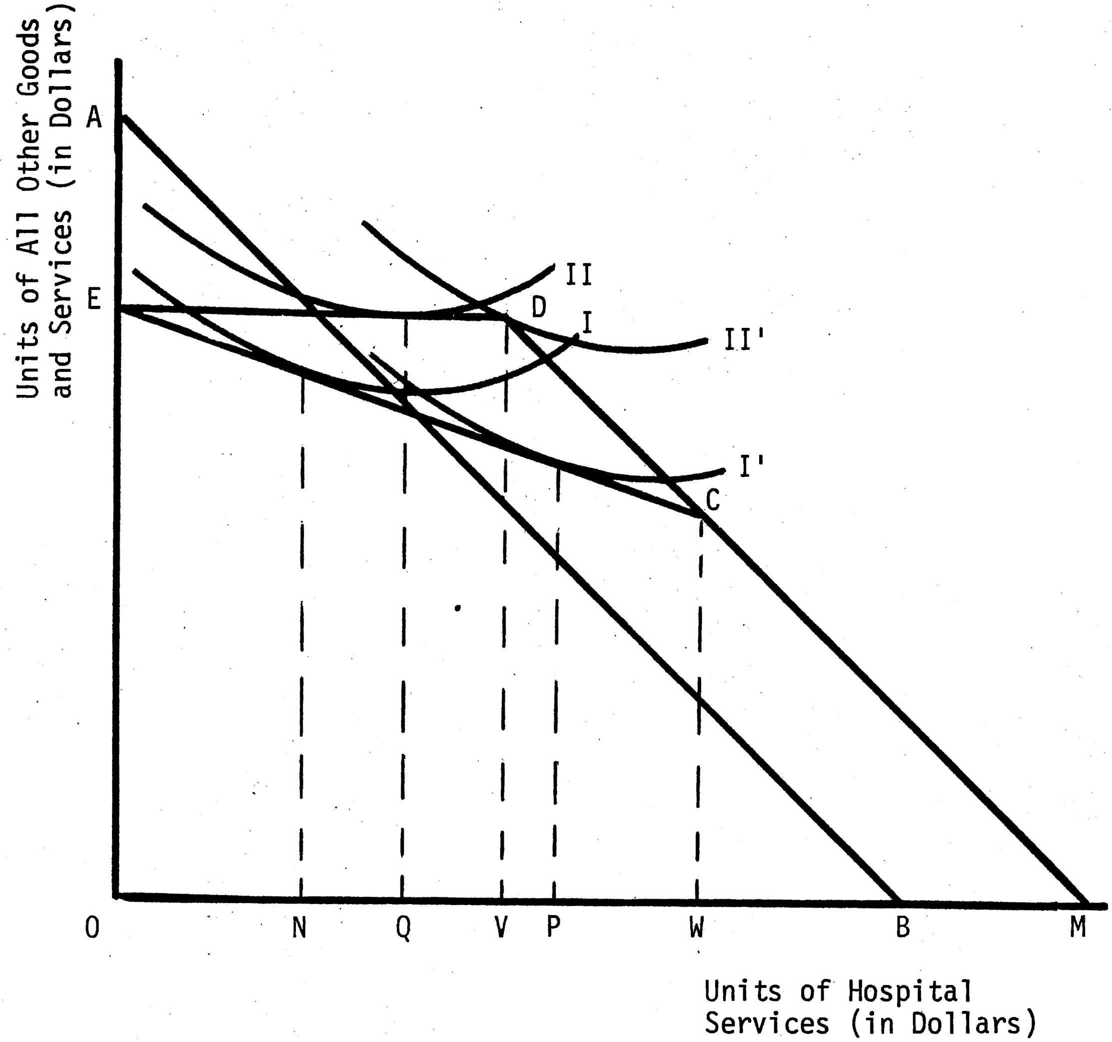

Figure 8. The Effects of Differing Percentage Coverages on the Purchase of Hospital Services

demanded than when the patient is required to pay a portion of each dollar of hospital services. However, at quantities beyond OV but less than OW the situation changes. Now, the holder of the first policy must pay in toto for each additional dollar of services beyond OV, whereas the second policy continues to pay a majority of the additional cost. Hence, under the first policy OV is demanded, while under the second policy OP is demanded. In both of these cases price effects are evident.

One important source of variation in payback ratios must still be considered. It cannot be neatly portrayed as can those above in graphical form, yet it cannot be overlooked. This is the possibility that benefits may be more difficult to collect from certain insurance companies, or perhaps from certain types of policies written by these companies. Even though price, coverage, deductibles, etc. are all the same for similar policies of two separate companies (assuming identical claims), one company may have a lower payback ratio simply because of refusal to pay claims via some pretext (unless pushed), slower handling of claims (thereby allowing the company more time to hold the premium before paying it out), or a refusal to pay items of a questionable nature whereas other companies pay them as a matter of policy. Many more of these non-quantifiable types exist; their importance is an empirical question.

An alternative means of showing that differing payback ratios can alter the price of hospital services as perceived by the individual can be shown mathematically. Consider the utility function

$$U = u(Y, H) \qquad (1)$$

where U is utility, Y is income, and H is hospital services consumed.

The consumer has total income Y_t. A portion of that is used to purchase hospital insurance, leaving the consumer with income Y_n. This insurance in turn pays a portion of his hospital costs so that

$$k = P_c/P_m \tag{2}$$

where k is the portion of price (per unit) which the consumer must pay, P_m is the per unit price of the hospital service, and P_c is the price to the consumer (out-of-pocket price). The out-of-pocket expenditures (E_p) for the group covered by the policy are then

$$E_p = k(P_m \cdot M) = P_c(M) = kE_t \tag{3}$$

where M is the quantity of hospital services consumed and E_t is total expenditures on hospital services for the group. Then

$$E_t = E_p + B \tag{4}$$

where B is the total benefits paid by the insurance company. Dividing through by E_t gives

$$\frac{E_t}{E_t} = \frac{E_p}{E_t} + \frac{B}{E_t}, \text{ or} \tag{5}$$

$$1 = \frac{kE_t}{E_t} + \frac{E_t - E_p}{E_t} \tag{6}$$

$$1 - k = \frac{E_t - E_p}{E_t} \tag{7}$$

Dividing (4) by premiums paid (N) gives

$$\frac{E_t}{N} = \frac{E_p}{N} + \frac{B}{N}, \text{ or} \tag{8}$$

$$\frac{E_t}{N} = \frac{E_p}{N} + R, \tag{9}$$

where R is the payback ratio. By linking (4) and (7) one obtains

$$1 - k = \frac{B}{E_t} = \frac{B}{N} \cdot \frac{N}{E_t}, \text{ or} \tag{10}$$

$$1 - k = R. \frac{N}{E_t} . \quad (11)$$

Therefore

$$k = 1 - R(\frac{N}{E_t}) \quad (12)$$

$$kP_m = P_m (1 - R \cdot \frac{N}{E_t}) \quad (13)$$

$$P_c = P_m (1 - R \cdot \frac{N}{E_t}) . \quad (14)$$

It can now be easily seen that the greater the value of R (the payback ratio), the lower the net price of hospital services to the consumer, ceteris paribus. Assume N/E_t equals one. If R = .5, the net price to the consumer is .5 P_m. If R = .9 (a higher payback ratio), the net price falls to .1 P_m.[40] If hospital services are characterized by a negatively sloped demand curve, then a decrease in the price perceived by the consumer should lead to an increase in the quantity of hospital services demanded.

The effect of differences in the payback ratio on quantity demanded is then an empirical question. The model to be tested is given in Chapter III. The empirical findings are presented and discussed in Chapter IV.

Summary

This chapter has reviewed prior attempts to estimate the demand for hospital services as well as other writings that pertain to the

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[40]Should N/E_t be less than one, it merely reduces the decrease in the net price given an increase in the payback ratio. For example, had N/E_t equaled only 0.5 in the example, the out-of-pocket price to the consumer would have been .75 P_m with a payback ratio of 0.5 and .55 P_m with a payback ratio of 0.9. In other words, the smaller the percentage of premiums paid to total expenditures on hospital services, the smaller the effect of changes in the payback ratio on the price of hospital services to the policyholder. The direction of the change in price, however, does not change.

hypothesis of this study. Although some past efforts have included insurance coverage as a variable, most treat it as a homogeneous good when in fact significant differences exist. Theoretical arguments for the inclusion of the payback ratio as an independent variable have been given, both graphically and mathematically, to illustrate the possible types of effects differing payback ratios would be expected to have on the demand for hospital services.

CHAPTER III

THE METHODOLOGY OF THE STUDY

Introduction

The indifference curve analysis and mathematical demonstration given in Chapter II suggest that various factors can cause differences in payback ratios, and that these differences may result in differing quantities of hospital services being demanded, ceteris paribus. In this chapter the basic methodology to be used in the statistical analysis of the effects of various factors, including the payback ratio, on the demand for hospital services is developed. The specific analytical models to be used are developed with consideration given to individual variables. The statistical techniques for analysis of the data are considered. Finally, the sources of data for the study are given.

The Theoretical Model

In determining a theoretical model of the demand for hospital services, one overwhelming variable immediately becomes evident -- illness or accident, thereby causing an immediate need for hospital services. In any given year, a majority of the people demand no hospital services because they remain healthy and, as a general rule, healthy people do not demand hospital services (with the major exception of pregnant women). All other variables would seem to be secondary to that of illness or accident. In any theoretical model, certainly a variable showing an immediate need for hospital services on the part of the individual would be included. However, it is obvious that in any empirical undertaking this variable must be omitted. It is possible that certain demographic variables (e.g., age, race) may well approximate some of this. For example, inasmuch as blacks are susceptible to sickle-cell anemia whereas whites are not, blacks may have a greater demand for hospital services, ceteris paribus. Urbanization might be a factor in demand if, due to air of a poorer quality and less exercise the urban dweller finds himself more susceptible to certain diseases (e.g., lung cancer) than his rural counterpart. If heart disease is positively correlated with age, then those areas with a concentration of elderly people might experience greater demand for hospital services than would otherwise be expected. But at best all of these are simply poor proxies for ascertaining the most important single variable, immediate need.

The general form of the theoretical model is:

$$D_{ni} = d\,(P_{ni}, P_{oi}, Y_i, S_i, P_{bi})$$

where

D_{ni} is the quantity of inpatient hospital services demanded per unit of time for individual i,

d is a functional relationship to be specified,

P_{ni} is the price of inpatient hospital services for individual i,

P_{oi} is the price of outpatient hospital services for individual i,

Y_i is the income per unit of time for individual i,

S_i is a vector of demographic and social characteristics of individual i, and

P_{bi} is the payback ratio of the insurance policy owned by individual i.

Also considered is a model of outpatient care

$$D_{oi} = f\,(P_{oi}, P_{ni}, Y_i, S_i, P_{bi})$$

where

D_{oi} is the quantity of outpatient hospital services demanded per unit of time by individual i,

f is a specified functional relationship, and

P_{oi}, P_{ni}, Y_i, S_i, and P_{bi} are as defined above.

Each of these variables is considered in more detail in the following section.

The Structure of the Empirical Model

The basic data are for the years 1970-1971, and are given by states. Each specific variable is examined below and the expected signs of the independent variables are discussed. An empirical evaluation of the appropriateness of each variable is considered in Chapter IV.

The quantity of hospital services demanded can be defined by several alternative measures. These are: (1) admissions per thousand population; (2) total hospital inpatient days per thousand population; or (3) average length of stay.[1] In addition, total outpatient visits per thousand population are used as a dependent variable to gain some measure of the substitutability of outpatient care for inpatient care

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[1]These are all commonly accepted measures of the quantity of hospital services demanded. Refer to the literature discussed in Chapter II in the section Examination of the Literature.

through the use of price cross-elasticities of demand.

Price can be defined in several different ways. Inpatient revenue per patient day, inpatient revenue per admission, and average room charge are all possible measures of the price of inpatient hospital services. It is hypothesized that the sign of the regression coefficient will be negative with respect to inpatient demand for any of these price measures. With respect to outpatient demand, it is hypothesized that the sign of the coefficient will be positive.[2] In addition, outpatient revenue per visit is used as the price variable for outpatient visits. It is hypothesized that its sign will be positive with respect to demand for inpatient services and negative for the demand for outpatient services.

The price variable used in this model is an average price. It is calculated ex post, as have been the price variables in the previously cited studies. L. D. Taylor has pointed out that such a demand calculation should use both average and marginal prices, and that these prices should be taken from a price schedule.[3] However, as this study uses statewide aggregated data, Taylor's suggestion cannot be followed. It is noted that the marginal price to the patient is probably less than the average price in that the majority of patients do not use up all their benefits. Thus the insurance company is still bearing a share of the cost. The omission of a marginal price variable may then result in a bias in the price variable.

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[2]If so, this would indicate that the two goods are substitutes as opposed to complements.

[3]Lester D. Taylor, "The Demand for Electricity: A Survey," The Bell Journal of Economics, VI (Spring, 1975), pp. 78-79.

The income variable, because the data are statewide, is simply the median income of all families in the state. It is hypothesized that its sign will be positive with respect to inpatient demand, indicating positive income elasticity of demand. With respect to outpatient demand, the expected sign is more difficult to determine. At first glance one would expect a positive sign; however, it is possible that outpatient visits are an inferior good, which would indicate a negative relationship between demand for outpatient services and income.

The variable dealing with age is specifically that percentage of a state's population over 65. It is hypothesized that its coefficient will have a positive sign for both inpatient and outpatient demand, in that the older the population the greater the probability of conditions requiring hospitalization, such as heart disease and cancer.

It is theoretically possible that those of a very young age might require more hospital services than "normal," thereby explaining some of the variation in quantities of hospital services demanded. Therefore the percentage of the state's population under five is also considered as an independent variable. The expected sign of the coefficient would be positive.

Race is expressed as that percentage of the state's population which is Caucasian. Inasmuch as the Negro, American Indian, Mexican American, and other minority groups traditionally receive poorer prenatal care than do Caucasians and may even be subject to diseases that do not affect the white element of the population (e.g., sickle-cell anemia), it is expected that there would be a negative relationship between the variable and the quantity of hospital services demanded, both inpatient and outpatient.

Sex is included for one specific reason. Women have babies, which in this culture frequently entails hospitalization. The variable is expressed as males per hundred females by state. It is hypothesized that the sign of the coefficient will be negative for inpatient demand. No specific hypothesis is made regarding outpatient demand.

Urbanization is defined as that percentage of the state's population living within the confines of a standard metropolitan statistical area (SMSA) as defined by the Department of Commerce. Some authorities argue that people who live near hospitals are more likely to use those facilities than those who live in areas where there are no hospitals. If this hypothesis is correct, the sign of the variable should be positive for both inpatient and outpatient demand. In addition, it is possible that the environment in SMSA's is of a poorer quality thereby leading to more disease and a greater demand for hospital services. This would reinforce the positive sign of the coefficient.

It might be argued that the SMSA designation is too narrow; that in fact hospitals can be found in many smaller towns. Therefore, a second definition of urbanization (that percentage of the state's population living in places with populations greater than 2,500) is considered to preclude this possibility. The hypotheses with respect to the signs of the coefficients would remain the same.

Therefore, the models to be tested empirically are

$$D_n = g\,(P_n,\ P_o,\ Y,\ A,\ R,\ X,\ U,\ C,\ P_b)$$

and

$$D_o = h\,(P_o,\ P_n,\ Y,\ A,\ R,\ X,\ U,\ C,\ P_b)$$

where

D_n is the demand for inpatient hospital services,

D_o is the demand for outpatient hospital services,

P_n is the price of inpatient hospital services,

P_o is the price of outpatient hospital services,

Y is income,

A is age,

R is race,

X is sex,

U is urbanization,

C is the percentage of the population covered by hospital insurance,

P_b is the payback ratio, and

g and h are functional relationships to be specified.

Use of the least-squares regression model for analysis of demand had been justified by Wold and Juréen.[4] Indeed, all of the studies citied in Chapter II use multiple regression analysis for obtaining their estimates.

The form of the regression model may be either additive (linear) or multiplicative (log-linear). An additive model is of the type

$$D_n = a + bP_n + cP_o + dY + \ldots + nP_b + e,$$

where a, b, . . ., n are the coefficients of the respective independent variables. A multiplicative model would be of the type

$$D_n = \alpha P_n^{\beta} P_o^{\gamma} Y^{\sigma} \ldots P_b^{\eta} e,$$

where β, γ, σ, . . ., η are all powers to which the respective variables

[4]Herman Wold and Lars Juréen, Demand Analysis: A Study in Econometrics (New York, 1953), pp. 28-59.

are raised. This could be rewritten

$$\log D_n = \log \alpha + \beta \log P_n + \gamma \log P_o + \sigma \log Y + \ldots + \eta \log P_b + e.$$

In other words, all that must be done is to enter the dependent and independent variables as logarithms and the multiple regression model will compute the coefficients for the logged data. Hence it is also referred to as a log-linear model, since it is linear in the logarithms.

Certain advantages accrue to the use of the log-linear model. One of these concerns the computation of elasticities of demand. It can be easily shown that the elasticities of the variables of an equation which is log-linear are simply the coefficients of that log-linear equation.[5] However, when using the additive model the elasticity coefficient holds only for a small segment about the means of the respective variables. Hence the use of the log-linear model avoids that criticism with respect to elasticities. Therefore, both models are tested.[6]

Statistical Techniques Employed

As stated above, the basic statistical tool used in this study is that of multiple linear regression. Specifically, the stepwise regression procedure is used. The characteristics of this procedure are worthy of mention.

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[5]Carl F. Christ, Econometric Models and Methods (New York, 1966), p. 79.

[6]The studies examined in Chapter II employed both linear and log-linear models. Davis and Russell and both articles by Rosenthal used log-linear models. In addition, Rosenthal also tried an additive model in The Demand for General Hospital Facilities. The remaining authors gave no clues as to whether the model they tested was linear or log-linear.

Regression analysis attempts to explain the extent to which certain independent variables react with the dependent variable. In its simplest form, that of linear regression with a single independent variable, the analysis attempts to fit a straight line so that the sum of the squared deviations of the actual observations from that fitted line are a minimum. The R-square (R^2) statistic is defined as the variation explained by the regression equation divided by the total variation of the dependent variable.[7] The remaining variation is called "residual." The residual occurs because of (1) lack of fit of the tested model (as opposed to what the true model would have achieved) and (2) pure error (also called "noise").[8]

Just as important as R^2, however, is the sign and value of the coefficient of the independent variable. Statistical techniques ascertain the probability that the coefficient is statistically different than zero. (A zero coefficient would indicate that there is no statistical relationship between the two variables.) Which of these properties is more important -- R^2 or value and sign of the coefficient -- is indeterminate; it depends upon the problem at hand.

In actual practice it is probable that several independent variables interact with the dependent variable. This implies that for n independent variables, in actuality an n-dimensional figure is being used from which the squared deviations of the observations from that figure are being measured.

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[7] Potluri Rao and Roger LeRoy Miller, Applied Econometrics (Belmont, California, 1971), p. 14.

[8] N. R. Draper and H. Smith, Applied Regression Analysis (New York, 1966), pp. 26-32.

Given a good theoretical model, it is not always clear exactly which variables should be included and which omitted. This leads to the problem of selecting the "best" regression equation. Unfortunately, there exists no single "best" method for doing this; several choices exist. These include (1) all possible regressions, (2) backward elimination, (3) forward selection, (4) stepwise regression, and (5) stagewise regression.[9] Draper and Smith believe stepwise regression to be the best of these techniques and recommend its use.[10] As it is the statistical technique used in this study, a brief discussion of its nature and properties is in order.

Stepwise regression involves a process in which the computer tries each regressor individually to ascertain which one is the "best" single regressor -- that is, causes the greatest reduction in residual sum of the squares (or yields the greatest R^2). Having selected this regressor, it then tries all others in combination with it, selecting that one which brings about the greatest total reduction in residual sum of the squares in concert with it (or the greatest improvement in R^2). It continues this pattern until (1) all regressors are included or (2) it reaches some predetermined minimum increase in R^2, at which point it terminates the search.

A major advantage of the stepwise regression technique is that the researcher can look for interaction between variables as they are introduced in the regression analysis. For example, this may allow him to detect an indication of multicollinearity between certain

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[9]Ibid., pp. 163-164.

[10]Ibid., p. 172.

variables. By watching the individual coefficients and the R^2 statistic, the researcher may also be able to identify more readily superfluous variables as well.

Sources of Data

The data for the dependent and independent variables in this study come from numerous sources. The primary source of data regarding admissions, length of stay, inpatient days, and outpatient visits by state is the Guide Issue of Hospitals.[11] Specifically, statewide data was obtained for non-federal, short-term general and other special hospitals. These include (1) non-governmental not for profit, (2) for profit, and (3) state and local governmental hospitals. Table 3 provided information on admissions, average stay, and total outpatient visits. Table 8 gave data on gross inpatient revenue, gross inpatient revenue per patient day, gross outpatient revenue, and gross outpatient revenue per patient visit.

Data for the sociological and demographic variables were obtained from the 1970 U. S. Census of the Population.[12] The following variables for each state are found in various tables and charts within each state's volume(s):

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[11]Until the 1971 data appeared, the Guide Issue was traditionally the second part of the August 1 edition of the magazine. However, beginning with the 1971 data, a separate volume was issued. Therefore the 1970 data were received from the August 1, 1971 Guide Issue of Hospitals. The 1971 data are from Hospital Statistics 1972 (Chicago, 1973).

[12]U. S. Bureau of the Census, Census of the Population: 1970 (Washington, D. C., 1972).

1. population;
2. urbanization (places of 2,500 or more);
3. urbanization (SMSA's);
4. race, percentage white;
5. sex, males per 100 females;
6. age, percent under five;
7. age, percent over 65;
8. education, median school years completed, those age 25 and over; and
9. income, median, all families in the previous year.

Data on numbers of persons covered by hospital insurance by type of plan by state were obtained from the Health Insurance Institute.[13] The information was converted to percentage coverage by dividing the number of persons covered by hospital insurance in a given state by that state's population.

The data on premiums paid and benefits were furnished by the Health Insurance Association of America. It is statewide data, broken down into four types of policies: (1) private companies' group policies; (2) private companies' individual policies; (3) Blue Cross-Blue Shield; and (4) independent plans. HIAA compiled the data obtained by their own survey, which drew responses from companies writing 85 percent of the hospital insurance premium volume. Data for those companies which failed to respond, or whose reports were incomplete, were estimated by HIAA from the premium volume of those companies as published annually

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[13] Health Insurance Institute, Source Book on Health Insurance Data, 73-74 (New York, 1974), p. 20.

in the May edition of _Health Insurance Statistical Review_, published by National Underwriter.

Summary

In this chapter both the theoretical model and the empirical model have been developed and discussed. The individual regressors have been listed. Expected signs of the coefficients were discussed. Attention was given to the statistical techniques used in the empirical analysis, specifically the use of the stepwise regression technique. Finally, the various sources of data used in the empirical study have been given.

CHAPTER IV

EMPIRICAL RESULTS

Introduction

This chapter presents the statistical results and analysis of the models presented in Chapter II pertaining to the demand for hospital services. The first section deals with certain econometric problems, specifically that of multicollinearity. The second section discusses the selection of the best measures of certain demographic and sociological variables where choices exist. The third section presents the results of the linear and log-linear regression models for the demand for inpatient hospital services utilizing two separate measures of inpatient demand. In the fourth section the results of the linear and log-linear regression models for outpatient demand are discussed. The statistical results are then analyzed. Comparisons of the results of this study with previous studies are made for both inpatient and outpatient demand. Differences between the two models of inpatient demand are analyzed. Finally, elasticity estimates for the economic variables are given and their meanings discussed.

Multicollinearity

In considering the various independent variables used in the model, it might appear at first glance that certain pairs of these variables might be collinear; that is, they might be expected to move together. Race and income, age and income, urbanization and income, and education and income are among the possible combinations of independent variables which might be expected to exhibit collinearity. To the extent that multicollinearity exists, it may impair the accuracy and stability of the parameter estimates.[1] Therefore, it was deemed essential to check for collinearity in the analysis.

The models tested use cross-section analysis. Multicollinearity tends to be a more pervasive problem in time-series analysis due to the tendency of economic variables to move together over time.[2] However, it can be a problem in cross-section analysis as well.

The first check made is a method based on Frisch's confluence analysis.[3] This method requires an elementary regression equation which appears to give plausible results. Then new independent variables are added and their effects on individual coefficients, standard errors, and overall R^2 are noted. Each variable is then classified as either useful, superfluous, or detrimental. If the new variable improves R^2 without rendering other coefficients unacceptable on a priori grounds, it is considered useful. If it does not cause much change in R^2 and does not considerably affect the values of the individual coefficients, it is considered superfluous. Should it affect the values of the coefficients, it is considered detrimental.[4] Should the individual

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[1]A. Koutsoyiannis, Theory of Econometrics (New York, 1973), p. 225.

[2]Ibid., p. 226.

[3]Ibid., pp. 230-231.

[4]Koutsoyiannis (p. 231) warns that this does not mean that the detrimental variable should be rejected, as that would merely cause specification error.

coefficients be affected in such a way as to become unacceptable on a priori considerations, then multicollinearity may be a serious problem.

Using this technique with stepwise regression, the education variable was deemed superfluous as in general it added about .002 to R^2 without causing any substantial change in the individual coefficients or their standard errors.

The second check made for multicollinearity is an examination of the correlation coefficients between the respective independent variables. These are given in Table 1 and are denoted $r_{x,y}$. Klein has argued that collinearity is harmful if

$$r^2_{x_i x_j} \geq R^2_{y \cdot x_1, x_2, \ldots, x_k}$$

where $r^2_{x_i x_j}$ is the simple correlation coefficient between any two explanatory variables (x_i and x_j) and $R^2_{y \cdot x_1, x_2, \ldots, x_k}$ is the overall (multiple) correlation coefficient of the relationship.[5] Hence, a check of these coefficients is in order.

Some surprising facts are evident. First, no coefficient among the independent variables is very large, the greatest being -.61112 for age (percent over 65) and sex (males per 100 females). Squared, this is .37347, certainly not large in absolute terms. The negative relationship is to be expected, given the fact that women have longer

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[5]Lawrence R. Klein, An Introduction to Econometrics (Englewood Cliffs, N. J., 1962), pp. 64, 101. It is recognized that the simple correlation coefficient is usually expressed as $r_{x_i x_j}$. However, by squaring this, problems associated with sign are eliminated as well as allowing comparison directly with the R^2 statistic.

TABLE II

CORRELATION COEFFICIENTS

Variables	U	A	S	R	Y	C_n	C_i	NPBR
D_{ia}	-.14891	.48062	-.41098	-.06653	-.41119	-.13831	.43168	.02136
D_{id}	.16012	-.08250	-.61690	-.09174	-.21044	.16051	.27199	-.07746
D_o	.51594	.01587	-.33412	-.37957	.26356	.44425	-.54995	-.17167
P_{ia}	.71269	-.00734	-.27919	-.07541	.67360	.50842	-.58758	-.04819
P_{id}	.57506	-.36995	.12125	-.10236	.72853	.28484	.69928	.05078
P_o	.36060	-.19097	.02553	.15606	.36060	.13075	-.25825	.07177
IPBR	-.32191	.28141	-.01644	.23276	-.37186	-.05603	.42622	-.12350
NPBR	-.02767	-.11112	.24004	.07468	-.08078	-.40845	.02470	1.00000
C_i	-.46345	.39802	-.14020	.08318	-.53623	-.40232	1.00000	
C_n	.38306	.14044	-.28713	.08035	.34009	1.00000		
Y	.54975	-.37910	.22556	-.02501	1.00000			
R	-.24117	.37065	.01725	1.00000				
S	-.38872	-.61112	1.00000					
A	-.04743	1.00000						
U	1.00000							

TABLE II (Continued)

Variables	IPBR	P_o	P_{id}	P_{ia}	D_o	D_{id}	D_{ia}
D_{ia}	.41238	-.10693	-.42163	-.26857	.06407	.74421	1.00000
D_{id}	.13232	.00541	-.20085	.17459	.31219	1.00000	
D_o	-.34726	-.19949	.39330	.53580	1.00000		
P_{ia}	-.39970	.48767	.77198	1.00000			
P_{id}	-.44455	.57124	1.00000				
P_o	-.05960	1.00000					
IPBR	1.00000						

life expectancies than men. The next largest coefficient relates income and education at .56404 ($r^2_{u, y}$ = .31814). The positive sign is as expected. The third largest coefficient relates urbanization and income at .54975 ($r^2_{y, e}$ = .30223). Again, the sign is as expected.

The only real surprise in Table II is the coefficient relating race (percent white) and income (median, all families) at -.02501. The sign is unexpected. A look at the individual observations reveals why this occurred. Washington, D. C. is 27.7 percent white -- the lowest of any observation -- yet has an above average median income ($9,583). Hawaii has the second lowest number of whites as a percentage of total population (38.8 percent) and has an even higher median income ($11,554). Alaska is also well below the average number of whites at 78.8 percent, but has the highest median income ($12,443). In neither of the latter two cases is the major non-white element black. However, no distinction is made in the data for blacks specifically. Hence the somewhat surprising sign of the coefficient can be understood in the light of these (and other) individual observations.

The magnitude of this coefficient is so small ($r^2_{r, y}$ = .00063) that the variables are virtually orthogonal. This seems to be the case among many of the variables.

As stated above, the largest r^2 for any of the independent variables (age and sex) is 0.37347, and the smallest R^2 for any estimated model is .55. In accordance with Klein's criterion, it appears that multicollinearity should not be a problem.

Klein's approach has been attacked by Farrar and Glauber.[6] They

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[6]Donald E. Farrar and Robert G. Glauber, "Multicollinearity in Regression Analysis: The Problem Revisited," <u>Review of Economics and Statistics</u>, XLIX (February, 1967), p. 98.

point out several circumstances (e.g., complete multicollinearity) that cause it to break down. To rescue the approach, they suggest comparing the overall multiple correlation coefficient $R^2_{Y \cdot x_1, x_2, \ldots, x_n}$ with the multiple correlation coefficient of each independent variable regressed on all other independent variables ($R^2_{x_1 \cdot x_2, x_3, \ldots, x_n}$). As a rule of thumb, Farrar and Glauber suggest that

> . . . a variable x_i then, would be said to be "harmfully multicollinear" only if its multiple correlation with other members of the independent variable set, R_{x_i}, were greater than the dependent variable's multiple correlation with the entire set, R_Y.[7]

The results of these additional regressions can be seen in Table III. Note that "high" R^2's are computed for inpatient price, age, sex, and income. It seems especially plausible that age and sex should attain these high values. Little can be done about the inpatient price and income variables, as these are central to the hypothesis of this thesis. Note that prior studies utilizing statewide data used these same variables and must have had similar results. Age and sex must be included in the model for theoretical reasons and are always statistically significant in the determination of inpatient demand.

Therefore, the results of this section are somewhat contradictory. The test suggested by Farrar and Glauber warns that multicollinearity might in fact impair the accuracy and stability of the parameter estimates. Yet using Klein's criterion, there should be no significant problem caused by multicollinearity. An analysis of the coefficients and their standard errors accomplished through the use of stepwise

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[7] Ibid.

TABLE III

INDEPENDENT VARIABLES' REGRESSIONS

Variable	Linear R^2	Log-linear R^2
Inpatient Revenue per Admission	.80676	.78809
Outpatient Revenue per Visit	.44080	.40120
% over 65	.66810	.75884
Race, % White	.49601	.40102
Sex, Males per 100 Females	.71935	.74710
Urbanization, % in SMSA's	.68777	.34717
Income	.79752	.71862
Individual Payback Ratio	.40570	.46873
Non-individual Payback Ratio	.29758	.25636
% Covered with Individual Policies	.58696	.61998
% Covered with Non-individual Policies	.49113	.51039

regression confirms this impression. Perhaps Rao and Miller are correct in their observation that multicollinearity "may often be largely a theoretical nightmare rather than an empirical reality."[8]

Selection of Appropriate Variables

As stated in Chapter III, several choices are available for both urbanization and age. Urbanization could be measured by either the percentage of the state's population within geographic confines of an SMSA, or those living in places with greater than 2,500 population. With respect to age, either those under five, those over 65, or a combination of the two (those under five or over 65) could be used.

Regressions of numerous models of the demand for hospital services were run changing only the urbanization variable between the two choices. Of these two, the percentage of the population within SMSA's gave substantially better empirical results than did those living in places with greater than 2,500 population. Therefore, the former variable was deemed a better definition of urbanization for the purposes of this study and was used in the regressions presented in the following sections.

The percentage of the state's population under five never appeared to be a significant factor in the demand for hospital services, whereas the percentage of the state's population over 65 is extremely important in the demand for inpatient hospital services. Therefore, the age variable was limited to that portion of the state's population over 65 in all reported models.

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[8]Potluri Rao and Roger LeRoy Miller, Applied Econometrics (Belmont, California, 1971), p. 48.

Depending upon the regression used, several other independent variables orginally chosen were found to be relatively unimportant in explaining the demand for hospital services. These are considered later in this chapter.

Multiple Regression Results: Estimation of the Demand for Inpatient Hospital Services

As stated in Chapter III, the basic model to be tested is

$$D_i = f(P_i, P_o, P_{bi}, P_{bn}, \ldots)$$

where P_{bi} is the payback ratio on individual policies, P_{bn} is the payback ratio on non-individual policies (e.g., Blue Cross-Blue Shield, group plans), and the other variables are as previously defined. Two measures of the quantity of inpatient hospital services demanded are considered: (1) inpatient hospital admissions per 1000 population, and (2) total hospital inpatient days per 1000 population. Both measures are used.

In addition, as previously mentioned numerous models of the demand function itself are possible. A linear (additive) model and a log-linear (multiplicative) model are both tried.

Consider the additive model using admissions per 1000 population as the dependent variable. The results given by the regression are:[9]

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[9] In the following equations, the numbers in parentheses below the coefficients are t-values. If the variable is significantly different from zero using the one-tailed t-test at the .1 level, the t-value is followed by one asterisk; at the .05 level, by two asterisks; at the .01 level, by three asterisks. If the predicted sign of the coefficient differs from the estimated sign, the predicted sign is placed in parentheses above the estimated sign. A summary of all the regression results listed in this chapter is in the Appendix.

$$D_{ia} = 270.06711 - .07035\,P_{ia} + 2.15150\,P_o + 98.13491\,P_{bi}$$
$$\qquad (1.83810)^{**} \quad (1.75522)^{**} \quad (2.33379)^{**}$$

$$+ 97.65575\,P_{bn} - .13310\,C_i - .05486\,C_n + .00461\,Y + 5.29432\,A$$
$$(1.59202)^{*} \quad (.43054) \quad (.23206) \quad (1.15733) \quad (2.37857)^{**}$$
$$(+)$$
$$- .77214\,R - 2.52733\,S - .22827\,U. \qquad R^2 = .552 \quad R = 4.37690$$
$$(2.95061)^{***} \quad (2.43508)^{***} \quad (1.30376)$$

Note that race and sex are statistically significant at the .01 level, while age, the individual payback ratio, inpatient price, and outpatient price are all significant at the .05 level. The non-individual payback ratio is significant at the .1 level. The entire equation is significant at the .0005 level.

Several things immediately stand out. First, the payback ratios have the expected signs and their regression coefficients are significantly different from zero (observed significance levels of .0117 for the individual payback ratio and .0578 for the non-individual payback ratio).[10] This gives empirical support to the hypothesis being tested. Secondly, the regression coefficient of the inpatient price variable, although small at .07, also exhibits the proper sign and is statistically significant at the .05 level. While the R^2 statistic is not absolutely high, it must be remembered that the most important variable, immediate need, could not be included. Indeed, this level of R^2 is very much in keeping with the results of other studies utilizing statewide data.

It is noteworthy that the income coefficient, while displaying the correct sign, is extremely small and has an observed significance level of only .1265. This is discussed further in this chapter.

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[10]Observed significance levels are determined by the computer. They give the exact level of confidence at which the coefficient becomes statistically different from zero.

The urbanization coefficient deserves some comment, in that it displays a sign contrary to that which is expected.[11] When examining the urbanization coefficient and its partial F-value in the stepwise regression procedure, it becomes evident that there is interaction between it and the income variable. This interaction apparently markedly changed the value of the coefficient.

The additive model using total hospital inpatient days per 1000 population as the dependent variable yields the following results:

$$D_{id} = 1577.74514 - \underset{(1.08725)}{3.70388\, P_{id}} + \underset{(1.97209)^{**}}{24.52555\, P_o} + \underset{(.39105)}{161.50385\, P_{bi}}$$

$$+ \underset{(1.12892)}{666.74681\, P_{bn}} + \underset{(.20467)}{.65247\, C_i} + \underset{(.67456)}{1.52378\, C_n} + \underset{(1.17192)}{.04119\, Y} + \underset{(3.69418)^{***}}{77.08266\, A}$$

$$- \underset{(3.69418)^{***}}{8.15899\, R} - \underset{(1.74976)^{**}}{16.85844\, S} \overset{(+)}{-} \underset{(.72780)}{1.25035\, U.} \quad R^2 = .605 \quad F = 5.43673$$

This model yields substantially different results than did the model using admissions per thousand population as the dependent variable (all independent variables are identical). While the overall R^2 and F-statistic are slightly higher for this equation, the economic variables (with the exception of the price of outpatient services) are never significant at the .1 level or better. All economic variables do exhibit the expected sign.

A log-linear model is also tested using the same dependent and independent variables as above.[12] Using the log of inpatient hospital

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[11] While this sign is unexpected, it is certainly not unique to the findings of this study. Gerald Rosenthal in <u>The Demand for General Hospital Facilities</u> also found a negative sign for the urbanization coefficient, as did Feldstein and Severson in "The Demand for Medical Care."

[12] All data were put in the form of natural logarithms.

admissions per 1000 population as the dependent variable yields the following results:

$$\log D_{ia} = \log 9.31782 - .28832 \log P_{ia} + .20631 \log P_o$$
$$\qquad\qquad (2.17308)^{**} \qquad (2.32937)^{**}$$

$$+ .21886 \log P_{bi} + .57472 \log P_{bn} + .02832 \log C_i + .01463 \log C_n$$
$$(2.02814)^{**} \quad (2.00714)^{**} \quad (.78180) \quad (.13725)$$

$$+ .17694 \log Y + .34945 \log A - .30952 \log R - .84488 \log S$$
$$(1.08584) \quad (3.39422)^{***} \quad (3.83480)^{***} \quad (1.43227)^{*}$$

$$(\pm) .01997 \log U. \qquad R^2 = .704 \qquad F = 8.43588$$
$$(1.80890)$$

The results when the log of total hospital inpatient days per 1000 population is used as the dependent variable in a log-linear model are:

$$\log D_{id} = \log 8.25104 - .16976 \log P_{id} + .21175 \log P_o$$
$$\qquad\qquad (.67763) \qquad (1.55247)^{*}$$

$$(\pm) .03467 \log P_{bi} + .45907 \log P_{bn} + .05832 \log C_i + .14284 \log C_n$$
$$(.21983) \quad (1.11138) \quad (1.00233) \quad (.92539)$$

$$+ .13371 \log Y + .56918 \log A - .35739 \log R - .60207 \log S$$
$$(.60844) \quad (3.70637)^{***} \quad (3.05866)^{***} \quad (.71754)$$

$$+ .00972 \log U. \qquad R^2 = .696 \qquad F = 8.13352$$
$$(.59941)$$

As explained in Chapter III, the coefficients of the independent variables in the log-linear models are the elasticity measures of those variables with respect to the dependent variable. Using admissions per 1000 population as the dependent variable, this gives a price elasticity of demand of -.29 and an income elasticity of demand of .18. (The income coefficient is not significant at the .1 level.) The cross-elasticity of demand of outpatient price with respect to admissions is .21. Using total hospital inpatient days per 1000 population as the demand measure yields a price elasticity of demand of -.17, an income elasticity of demand of .13, and a cross-elasticity of demand of outpatient price of .21. (Neither the price nor the income coefficient in the inpatient days model is significant at the .1 level.)

Multiple Regression Results: Estimation of the Demand for Outpatient Hospital Services

In general, the model for estimating outpatient demand explains a larger percentage of the total variation about the mean than the model for inpatient demand achieves. This may be explained by the fact that outpatient hospital services are, as a general rule, less urgent than inpatient hospital services. These services are more readily postponed or avoided altogether than inpatient hospital services. In addition, there exists the possibility of substituting a visit to the office of one's physician to accomplish the treatment. In short, the immediate need spoken of in Chapter II is probably less evident in the case of outpatient demand than in the case of inpatient demand.

It seems likely that the payback ratio should have little impact on the demand for outpatient hospital services. The data tend to support this conclusion. Consider the following results for the additive model:

$$D_o = 2313.84115 - \underset{(4.06971)^{***}}{36.25988\,P_o} + \underset{(.90755)}{.25246\,P_{ia}} + \underset{(.66796)}{204.15561\,P_{bi}}$$

$$+ \underset{(.34205)}{152.50693\,P_{bn}} - \underset{(3.81217)^{***}}{8.56610\,C_i} + \underset{(.66254)}{1.13849\,C_n} + \underset{(1.79563)^{**}}{.05196\,Y} + \underset{(1.26519)}{20.46931\,A}$$

$$- \underset{(3.32237)^{***}}{6.31954\,R} - \underset{(2.07281)^{**}}{15.63724\,S} - \underset{(.13668)}{.17394\,U}. \quad R^2 = .770 \quad F = 11.86038$$

The entire equation is significant at the .0001 level.

Using a multiplicative model the following results are obtained:

$$\log D_o = \log 19.66419 - .84865 \log P_o + .27237 \log P_{ia}$$
$$(5.58408)^{***} \quad (1.19637)$$

$$+ .05687 \log P_{bi} + .08227 \log P_{bn} - .23361 \log C_i + .17016 \log C_n$$
$$(.30715) \quad (.16744) \quad (3.75878)^{***} \quad (.93044)$$

$$+ .54705 \log Y - .04243 \log A - .18564 \log R - 3.66366 \log S$$
$$(1.95639)^{**} \quad (.24020) \quad (1.34041)^{*} \quad (3.61949)^{***}$$

$$- .00888 \log U. \qquad R^2 = .815 \qquad F = 15.59610$$
$$(.46872)$$

Again, since the coefficients of the variables of the log-linear model are the elasticity estimates of those variables, the analysis yields a price elasticity of demand of -.85, an income elasticity of demand of .54, and a cross-elasticity of demand of inpatient price of .27. (The inpatient price variable is not significant at the .1 level.) Outpatient price, individual coverage, and sex are all significant at the .01 level; income is significant at the .05 level, and race is significant at the .1 level.

Interpretation and Implications of the Empirical Results: Inpatient Demand

The regression equations presented earlier in this chapter provide support for the hypothesis of this study, that higher payback ratios are associated with larger quantities of hospital services demanded. The use of admissions per 1000 population as the dependent variable provides more support for the hypothesis than does the use of total hospital inpatient days per 1000 population. The reasons for this are discussed below.

Consider the first model presented using admissions per 1000 population as the dependent variable in a linear model. As mentioned in this chapter, race and sex are significant at the .01 level, with age having an observed significance level of .0106. These variables, which may well be the best proxies available for need, continually achieve these high levels of significance in the demand for inpatient hospital services.

The economic variables display the correct signs and generally achieve acceptable levels of significance. Specifically, inpatient price is significant at the .0352 level, income at the .1265 level, the individual payback ratio at the .0117 level, and the non-individual payback ratio at the .0579 level. Note the great similarity of the coefficients for the individual payback ratio (98.13491) and the non-individual payback ratio (97.65575). The overall R^2 is .552, and the F-statistic of 4.37690 is significant at the .0005 level.

When using total hospital inpatient days per 1000 population as the measure of quantity demanded, the results change significantly. While the demographic and sociological variables retain their importance (age and race are significant at the .01 level, while sex is significant at the .05 level), the economic factors (inpatient price, the payback ratios, and income) are no longer significant at the .1 level or better.

The coefficients of the payback ratios are much larger in the inpatient days model (161.50385 and 666.74681 for the individual and non-individual payback ratios respectively). As total hospital inpatient days is equal to admissions times average length of stay (typically about 7.5 days) one would expect that the coefficients for all the independent variables would be larger in absolute value in the inpatient days model as opposed to the admissions model. In fact, the absolute value of every coefficient in the inpatient days model is greater than the coefficient for the respective variable in the model using admissions as the dependent variable. The intercept for inpatient days (1577.74514) is about six times that for the admissions model (270.06711). This makes sense given the average length of stay. Note, however, that with regard to the payback ratio the standard errors of these coefficients are so large that serious doubt is cast on the validity of these estimates.

As mentioned above, the economic variables differ greatly in their levels of significance between the two models of inpatient demand. It would seem that some discussion is in order to explain why economic variables are statistically important in explaining hospital admissions but so seemingly unimportant in explaining total hospital inpatient days. The answer must lie in the person charged with making the respective decisions. The decision to gain admission to the hospital is made by the patient. The physician advises him, but the decision is his. He can judge the various economic factors -- price, income, insurance coverage -- in concert with his physician's recommendations and arrive at a decision on whether or not to utilize the hospital's facilities. Once admitted, the patient relinquishes this decision-making role, placing it in the hands of the attending physician. Society, the hospitals, or the physicians themselves have deemed the physician a better judge of when the patient is ready for dismissal. The physician can consider medical factors (possibly along with his own utility function) in making this decision. Certainly these aforementioned economic factors play a smaller role in the physician's decision than they would were the patient himself making the decision.[13] Hence the difference in the importance of these economic factors between these two models occurs.

In the log-linear model using admissions, age and race are both significant at the .01 level. The individual payback ratio has an observed significance level of .0234, the non-individual payback ratio of .0245, and inpatient revenue per admission of .0169. Outpatient revenue per visit has an observed significance level of .0119. Sex is statistically significant at the .1 level. In short, the economic variables are in fact statistically different from zero under generally accepted criteria.

Using inpatient days as the dependent variable in a log-linear model again sharply reduces the statistical importance of the various economic variables, as it did in the linear model.[14] The observed significance level (one-tail test) for the individual payback ratio goes to .4109; for the non-individual payback ratio, .1363; and for inpatient revenue per patient day, .2545. Only outpatient revenue per visit retains statistical significance at better than the .1 level with an observed significance level of .0650. As mentioned above, age and race are again significant at the .01 level.

The coefficients of the log-linear models are important in that they are elasticity estimates. Using admissions as the dependent

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[13]This is most vividly seen in long-term patients with terminal illnesses, who sometimes request the cessation of certain life-sustaining treatments in order to avoid depleting the financial resources and placing their survivors in a precarious financial position.

[14]The sole difference in the data was the necessity of entering 0.1 instead of 0.0 as the percent of the state's population within SMSA's for Alaska, Vermont, and Wyoming, as the computer cannot accept the natural log of zero.

variable gives an income elasticity of demand of .177 and a price elasticity of -.288. (The income coefficient is not significant at the .1 level.) This compares with Davis and Russell's estimates of -.22 and -.19 for income and price respectively.[15] Feldstein and Severson found elasticity estimates of -.7629 for income and .1102 for price.[16]

The payback ratios used in this study had coefficients of .219 and .575 in the admissions model. The implication of the data in this study is that a 10 percent increase in the payback ratio would be associated with a 2 to 6 percent increase in hospital admissions per 1000 population, while a 10 percent increase in income would be associated with somewhat less than a 2 percent increase in hospital admissions per 1000 population. A 10 percent increase in price would, ceteris paribus, be associated with about a 3 percent decrease in hospital admissions per 1000 population.

Additional runs were made omitting the payback ratio to see if this would significantly alter either the income or price coefficients. No significant changes in the coefficients occurred, although in the models using admissions per 1000 population as the dependent variable overall R^2 fell from .552 to .472 in the linear estimation and from

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[15] Karen Davis and Louise B. Russell, p. 114.

[16] Paul J. Feldstein and Ruth M. Severson, p. 67. The negative sign associated with income in both studies and the positive sign associated with price in the Feldstein-Severson study make absolutely no sense from an economist's point of view. Feldstein and Severson (p. 67) and Davis and Russell (p. 116) both suggest the negative sign of the income variable to be caused by multicollinearity between income and other variables; Feldstein and Severson suggest insurance, Davis and Russell inpatient price. Feldstein and Severson do not specifically comment on the sign of the price variable.

.704 to .648 in the log-linear estimation.

Age, race, and sex have the expected signs in all models of inpatient demand and are generally significant at the .01 level.[17] The age coefficients in the log-linear estimations indicate that a 10 percent increase in the portion of a state's population over 65 would increase hospital admissions by 3.5 percent and total hospital inpatient days by 5.7 percent. Similarly, the race coefficients show that a 10 percent increase in the portion of the state's population which is white would be associated with a 3.1 percent reduction in admissions and a 3.6 percent reduction in inpatient days. The coefficients of the sex variable indicate that a 10 percent increase in males per 100 females would be associated with an 8.4 percent reduction in hospital admissions and a 6 percent reduction in total hospital inpatient days. The reasons for the expected directions of these results have been discussed in Chapter III.

The insurance coverage variables have the expected (positive) sign, but their values are extremely small in the admissions model. This especially stands out when compared to the values of the payback ratios.

Interpretation and Implications of the Empirical Results: Outpatient Demand

The estimated models of outpatient demand reveal some distinct departures from the results of the inpatient demand models. First,

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[17]Exceptions to this are found for age in the linear admissions model (observed significance level of .0106) and for sex in both log-linear estimations.

the age coefficients fall dramatically in statistical significance (observed significance levels of .1055 and .4033) and value (20.47 and -.042 in the linear and log-linear estimations respectively). This compares with observed significance levels of .0106, .0010, .0012, and .0005 and coefficients of 5.29, .349, 77.08, and .569 for the linear admissions, log-linear admissions, linear inpatient days, and log-linear inpatient days models respectively. An obvious explanation is that many conditions afflicting those over 65 require hospitalization; there is little statistical evidence in the data showing them to have a significantly greater number of conditions which are treated in outpatient status than does the rest of the population. This same deemphasis of sociological and demographic variables continues through the race and urbanization variables as well.

This deemphasis does not continue through sex. The sex coefficients of -15.64 and -3.66 (significant at the .0212 and .0006 levels respectively) for the linear and log-linear models is not much of a change from the direction established for inpatient demand. The coefficient of the sex variable in the log-linear model is interpreted as meaning that if males per 100 females fell by 10 percent, total hospital outpatient visits would rise by 36.6 percent -- a rather sharp increase. The only apparent explanation lies in the prenatal examinations many such facilities offer and which are used exclusively by female patients.

The second main area of departure occurs between outpatient demand and the inpatient days model. It is a reemphasis of the price and income variables. This is most vividly seen in the outpatient price variable. Its value is -36.26 in the linear model and -.849 in the log-linear model. While demand for outpatient hospital services is still price inelastic, the coefficient of -.849 indicates that a 10 percent increase in the price of an outpatient visit would be associated with a decrease of 8.5 percent in quantity demanded. This is comparable with Davis and Russell's findings of a price elasticity of -1.00.[18] In addition, the income variable also plays a more significant role, having coefficients of .05 and .547 with observed significance levels of .0384 and .0273 for linear and log-linear estimations. Again, this indicates that a 10 percent increase in income would be associated with a 5.5 percent increase in outpatient visits per 1000 population. This is considerably more elastic than the elasticity estimate for admissions (.177) or for inpatient days (.134). The cross-elasticity of demand with respect to inpatient price is estimated at .272.

In short, the demand for outpatient visits reacts with price and income in a more aggresive manner than does the demand for inpatient hospital services. The reason for this must lie in the nature of the services provided. A list of those factors invariably used in principles textbooks to explain what goods would be expected to have price elastic demand and vice-versa inevitably includes necessity versus luxury. While most outpatient visits could in no way be regarded as a luxury, neither are they generally as much a necessity as are those treatments accomplished on inpatients. Hence, while outpatient demand is still price inelastic, it is substantially less price inelastic than is inpatient demand for hospital services.

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[18]Karen Davis and Louise B. Russell, pp. 112, 116.

Summary

Chapter IV has dealt with the statistical and econometric problems which exist in this and similar studies. An attempt has been made to meet these problems. Multicollinearity was discussed. The results were somewhat mixed, with certain key variables (e.g., price, income, age, and sex) being potential problems. The selection of specific definitions of certain independent variables was made with appropriate reasons given. The results of the various regressions on both inpatient and outpatient demand, using both linear and log-linear models, were presented. These empirical results were analyzed and discussed. Suggestions have been made to account for the differing results in the different models of inpatient demand. Central to this discussion were the reasons for the significant differences between the admissions model and the inpatient days model in both linear and log-linear estimations. The coefficients of the specific variables have been analyzed. Finally, the outpatient demand model has been discussed, its coefficients analyzed and interpreted.

CHAPTER V

SUMMARY AND CONCLUSIONS

The results of this study show that the demand for hospital services is partially determined by economic factors. It does not suffer from the unexpected results of either the Davis-Russell study (negative income elasticity) or the Feldstein-Severson study (negative income elasticity and positive price elasticity) alluded to in Chapter IV. While certain demographic and sociological variables (specifically age, race, and sex) explain a large portion of the variation in statewide demand for inpatient hospital services, economic variables (price and payback ratios) are also statistically important in accounting for this variation.

Insurance has the effect of altering the line of attainable combinations as well as the price of hospital services as perceived by the patient. However, insurance policies are not homogeneous goods. One way of showing the differences between them is with the payback ratio. The empirical results of this study support the hypothesis that higher payback ratios are associated with greater quantities of hospital services demanded, due to both income and price effects.

Models of outpatient demand were also tested. They showed variations between insurance policies to be much less important in explaining variations between states. Further, age was found to be much less significant as a factor in the demand for outpatient visits. The elasticities of both income and price are greater for outpatient demand than for inpatient demand.

As federal legislation comes about, it would seem probable that certain minimum standards of performance will be placed upon either the private companies writing the policies or on the federal agencies involved. The attainment of these standards would be most likely verified by either the GAO or by the various state insurance commissions. As the program will be comprehensive, it seems plausible to assume that for those holding individual policies, the payback ratios of their "policies" under the new program would certainly rise, due in part to economies of scale. Hence, for this group, the data indicates an increase in the quantity of hospital services demanded will occur. Whether or not the payback ratio will be greater than, equal to, or less than that currently existing for those holding group policies is purely conjectural. Certainly the direct benefits of such legislation among those currently holding hospital insurance will be greatest among that segment of policyholders owning individual policies.

Data show that the likelihood of owning hospital insurance is directly related to income. Whereas in 1970 90.1 percent of all persons in families with incomes of $10,000 or more had hospital insurance coverage, only 39.9 percent of those in families with incomes of less than $3,000 were so covered.[1] There are no statistics available on the incomes of those holding individual policies as opposed to those holding group policies. However, it would seem obvious that the individual

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[1]U. S. Department of Health, Education and Welfare, Medical Care Expenditures, Prices and Costs: Background Handbook (Washington, D. C., 1973), p. 83.

policyholder is one who cannot obtain a group policy, either because of discrimination or cost. They may be below the median level of income; given this criterion, they are probably disproportionately aged or non-white. As most large companies generally provide group hospital insurance as a fringe benefit and tend to be located in urban areas, it would seem that a disproportionate number of them would be from rural areas.[2]

Hence this study shows that price is a determinant of demand. Those legislative proposals which effectively do away with the price variable are essentially eliminating one measure of control of quantity demanded. While it may seem humanitarian to argue that everyone should receive all the medical care one needs, this effectively ignores reality, with its problems of scarcity of resources. Inasmuch as age, race, and sex cannot be effectively controlled as determinants of demand by the legislative authority, one of the few controls left is price.

Suggestions for further research in this area primarily involve the acquisition of data on a disaggregated basis. While the data on payback ratios are the best currently available, it would be beneficial to look at individuals as the unit of observation rather than states. The disaggregation would hopefully separate the demand for hospital services for different illnesses and conditions. This would necessarily be a large undertaking in order to get a sufficient sample size.

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[2]Although farm cooperatives and similar groups will frequently set up group policies for their members, those unable to afford the coverage are still effectively closed out.

BIBLIOGRAPHY

American Hospital Association. Hospitals. Chicago, Illinois, 1971.

American Hospital Association. Hospital Statistics 1972. Chicago, Illinois, 1973.

Andersen, Ronald and Odin W. Anderson. A Decade of Health Services: Social Survey Trends in Use and Expenditure. Chicago: University of Chicago Press, 1967.

Andersen, Ronald and Lee Benham. "Factors Affecting the Relationship between Family Income and Medical Care Consumption," in Herbert E. Klarman (ed.). Empirical Studies in Health Economics. Baltimore: Johns Hopkins University Press, 1970.

Arrow, Kenneth J. "The Economics of Moral Hazard: Further Comment." American Economic Review, LVIII (June, 1968), pp. 537-539.

__________. "Uncertainty and the Welfare Economics of Medical Care." American Economic Review, LIII (December, 1963), pp. 941-973.

"California Issues Minimum Standards for Health Insurance." Modern Hospital, CXIX (December, 1972), p. 42.

Cathles, L. M., Jr. "Minimum Premium Health Plans: Insured Non-Insurance: Comment." Journal of Risk and Insurance, XXXVII (September, 1970), pp. 477-480.

Christ, Carl F. Econometric Models and Methods. New York: John Wiley and Sons, Inc., 1966.

Crew, M. "Coinsurance and the Welfare Economics of Medical Care." American Economic Review, LIX (December, 1969), pp. 906-908.

Crosslin, Robert L. Private Insurance Company Individual Policies in Mississippi: Specific Company Rankings of Premium Costs and Benefit Payments in 1970-1971. Jackson, Mississippi: Mississippi Select Committee for Health, 1974.

Davis, Karen. "Economic Theories of Behavior in Nonprofit, Private Hospitals." Washington, D. C.: The Brookings Institution, Reprint No. 239, August, 1972.

Davis, Karen and Louise B. Russell. "The Substitution of Hospital Outpatient Care for Inpatient Care." The Review of Economics and Statistics, LIV (May, 1972), pp. 109-120.

Draper, N. R. and H. Smith. Applied Regression Analysis. New York: John Wiley and Sons, 1966.

Eilers, Robert D. "Minimum Premium Health Plans: Insured Non-Insurance." Journal of Risk and Insurance, XXXVI (March, 1969), pp. 63-84.

Farrar, Donald E. and Robert G. Glauber. "Multicollinearity in Regression Analysis: The Problem Revisited." Review of Economics and Statistics, XLIX (February, 1967), pp. 92-107.

Federal Reserve Board. Federal Reserve Bulletin, Vol. LXI. Washington, D. C., May, 1975, p. A-54.

Fein, Rashi. The Doctor Shortage: An Economic Analysis. Washington, D. C.: The Brookings Institution, 1967.

Feldstein, Martin S. Economic Analysis for Health Service Efficiency. Amsterdam: North Holland Publishing Co., 1967.

Feldstein, Paul J. "Research on the Demand for Health Services." Milbank Memorial Fund Quarterly, XLIV (July, 1966), pp. 128-165.

__________ and J. W. Carr. "The Effect of Income on Medical Care Spending." Proceedings of the Social Sciences Section. Washington, D. C.: American Statistical Association, 1964, pp. 93-105.

__________ and Ruth M. Severson. "The Demand for Medical Care." Report of the Commission on the Cost of Medical Care, Vol. I. Chicago: American Medical Association, 1964, pp. 57-76.

Friedman, Bernard. "Risk Aversion and the Consumer Choice of Health Insurance Option." The Review of Economics and Statistics, LVI (May, 1974), pp. 209-214.

Ginsburg, Paul B. and Larry M. Manheim. "Insurance, Copayment, and Health Services Utilization: A Critical Survey." Journal of Economics and Business, Spring-Summer, 1973, pp. 142-153.

Glaser, William A. Paying the Doctor. Systems of Renumeration and their Effects. Baltimore: The Johns Hopkins Press, 1970.

Greene, Mark R. Risk and Insurance. 2nd Ed. Cincinnati, Ohio: South-Western Publishing Co., 1968.

Greenlick, Merwyn R. "The Impact of Prepaid Group Practice on American Medical Care: A Critical Evaluation." The Annals of the American Academy of Political and Social Science, 399 (January, 1972), pp. 100-113.

Grossman, Michael. "On the Concept of Health Capital and the Demand for Health." Journal of Political Economy, CLXXX (April, 1972), pp. 223-255.

Havighurst, Clark C. "Health Maintenance Organizations and the Market for Health Services." Law and Contemporary Problems, XXXV (Autumn, 1970), pp. 716-795.

Health Insurance Institute. Source Book of Health Insurance Data. 1973-74 Ed. New York, 1972.

Hibbard, Thomas H. "Insurance and the Optimal Distribution of Medical Care." Western Economic Journal, IX (September, 1971), pp. 231-241.

Joseph, Hyman. "Empirical Research on the Demand for Health Care." Inquiry, VIII (March, 1971), pp. 61-71.

__________. "Hospital Insurance and Moral Hazard." Journal of Human Resources, VII (Spring, 1972), pp. 152-161.

Kamien, Morton I. and Nancy L. Schwartz. "Payment Plans and the Efficient Delivery of Health Care Services." Journal of Risk and Insurance, XL (September, 1973), pp. 427-436.

Kessel, Reuben A. "The A.M.A. and the Supply of Physicians." Law and Contemporary Problems, XXXV (Spring, 1970), pp. 267-283.

Kittner, D. R. "Changes in Health and Insurance Plans." Monthly Labor Review, XCIII (February, 1970), pp. 32-39.

Klarman, Herbert E. "Major Public Initiatives in Health Care." The Public Interest, No. 34 (Winter, 1974), pp. 106-123.

__________. "Reimbursing the Hospital -- The Differences the Third Party Makes." Journal of Risk and Insurance, XXXVI (December, 1969), pp. 553-566.

__________. "Reimbursing the Hospital -- The Differences the Third Party Makes: Author's Reply." Journal of Risk and Insurance, XXXVIII (March, 1971), pp. 139-141.

__________. The Economics of Health. New York: Columbia University Press, 1965.

Klein, Lawrence Robert. An Introduction to Econometrics. Englewood Cliffs, N. J.: Prentice-Hall, 1962.

Kolodrubetz, Walter W. "Group Health Insurance Coverage of Full-Time Employees, 1972." Social Security Bulletin, XXXVII (April, 1974), pp. 17-35.

Koutsoyiannis, A. Theory of Econometrics. New York: Barnes & Noble, 1973.

Lave, Judith R. and Lester B. Lave. "Medical Care and its Delivery: An Economic Appraisal." Law and Contemporary Problems, XXXV (Spring, 1970), pp. 252-266.

Malisoff, H. "Reimbursing the Hospital -- The Differences the Third Party Makes: Comment." Journal of Risk and Insurance, XXXVIII (March, 1971), pp. 137-139.

Mueller, Marjorie Smith. "Private Health Insurance in 1971: Services, Enrollment, and Finances." Social Security Bulletin, XXXVI (February, 1973), pp. 3-22.

__________. "Private Health Insurance in 1973: A Review of Coverage, Enrollment, and Financial Experience." Social Security Bulletin. XXXVIII (February, 1975), pp. 21-40.

Mushkin, Selma J. (ed.). The Economics of Health and Medical Care. Ann Arbor: Bureau of Public Health Economics, University of Michigan, 1964.

"National Health Insurance Proposals Pending in the 93rd Congress." The Congressional Digest, LIII (June-July, 1974), pp. 168-192.

Newhouse, Joseph P. and Vincent Taylor. "The Subsidy Problem in Hospital Insurance: A Proposal." Journal of Business, University of Chicago, XLIII (October, 1970), pp. 452-456.

Pauly, Mark V. "A Measure of the Welfare Cost of Health Insurance." Health Services Research, IV (Winter, 1969), pp. 281-292.

__________. "Overinsurance and Public Provision of Insurance: The Roles of Moral Hazard and Adverse Selection." Quarterly Journal of Economics, LXXXVIII (February, 1974), pp. 44-62.

__________. "The Economics of Moral Hazard: Comment." American Economic Review, LVIII (June, 1968), pp. 531-537.

Rao, Potluri and Roger LeRoy Miller. Applied Econometrics. Belmont, California: Wadsworth Publishing Co., 1971.

Rayack, Elton. Professional Power and American Medicine: The Economics of the American Medical Association. Cleveland: World Publishing Co., 1967.

Robertson, Robert. "Comparative Medical Care Use Under Prepaid Group Practice and Free Choice Plans: A Case Study." Inquiry, IX (September, 1972), pp. 70-76.

Rosenthal, Gerald D. The Demand for General Hospital Facilities. Hospital Monograph Series No. 14. Chicago: American Hospital Association, 1964.

Rossett, Richard N. and Lien-fu Huang. "The Effect of Health Insurance on the Demand for Medical Care." Journal of Political Economy, LXXXI (March/April, 1973), pp. 281-305.

Rothenberg, Jerome. "Welfare Implications of Alternative Methods of Financing Medical Care." American Economic Review, XLI (May, 1951), pp. 676-687.

Scotton, R. B. "Membership in Voluntary Health Insurance." Economic Record, XLV (March, 1969), pp. 69-83.

Short, J. H. "Is Health Care an Economic Commodity?" Intermountain Economic Review, IV (Spring, 1973), pp. 14-21.

Somers, Herman and Anne R. Somers. Doctors, Patients, and Health Insurance. Washington, D. C.: The Brookings Institution, 1961.

Taylor, Lester D. "The Demand for Electricity: A Survey." The Bell Journal of Economics, VI (Spring, 1975), pp. 76-110.

Toerber, Garry A. An Evaluative Analysis of Medical Care Financing Systems with Particular Emphasis on a National Health Insurance. Health Care Research Series No. 20. Iowa City, Iowa: University of Iowa Press, 1972.

Tunley, Roul. The American Health Scandal. New York: Harper and Row, 1966.

U. S. Bureau of the Census. Census of the Population: 1970. Washington, D. C., 1972.

U. S. Department of Commerce. Survey of Current Business, Vol. LV. Washington, D. C., August, 1975, p. S-8.

U. S. Department of Health, Education, and Welfare. Medical Care Expenditures, Prices and Costs: Background Book. Washington, D. C., September, 1973.

Weisbrod, Burton and Robert J. Fiesler. "Hospital Insurance and Hospital Utilization." American Economic Review, LI (March, 1961), pp. 126-132.

Weiss, Jeffery H. and Lynda Brodsky. "An Essay on the National Financing of Health Care." Journal of Human Resources, VII (Spring, 1972), pp. 139-151.

Wold, Herman O. and Lars Juréen. Demand Analysis: A Study in Econometrics. New York: John Wiley and Sons, 1953.

Worthington, Nancy L. "National Health Expenditures, 1929-1974." Social Security Bulletin, XXXVIII (February, 1975), pp. 3-20.

Zeckhauser, Richard. "Medical Insurance: A Case Study of the Trade Off Between Risk Spreading and Appropriate Incentives." Journal of Economic Theory, II (March, 1970), pp. 10-26.

APPENDIXES

SUMMARY OF THE REGRESSION RESULTS

Model Variables	D_{ia}	D_{id}	log D_{ia}	log D_{id}	D_o	log D_o
Intercept	270.06711	1577.74514	9.31782	8.25104	2313.84115	19.66419
P_{ia}	-.07035**		-.28832**		.25246	.27237
P_{id}		-3.70388		-.16976		
P_o	2.15150**	24.52555**	.20631**	.21175*	-36.25988***	-.84865***
P_{bi}	98.13491**	161.50385	.21886**	-.03467	204.15561	.05687
P_{bn}	97.65575*	666.74681	.57472**	.45907	152.50693	.08227
C_i	-.13310	.65247	.02832	.05832	-8.56610***	-.23361***
C_n	-.05486	1.52378	.01463	.14284	1.13849	.17016
Y	.00461	.04119	.17694	.13371	.05196**	.54705**
A	5.29432**	77.08266***	.34945***	.56918***	20.46931	-.04243
R	-.77214***	-8.15899***	-.30952***	-.35739***	-6.31954***	-.18564*
S	-2.52733***	-16.85844**	-.84488*	-.60207	-15.63724**	-3.66366***
U	-.22827	-1.25035	-.01997	.00972	-.17394	-.00888

The coefficients on the preceding page are taken from the regression results analyzed and presented in Chapter IV. Whenever the model is logarithmic, the variables are also logged. As is the practice in Chapter IV, any coefficient that is significant at the .1 level is followed by a single asterisk; if significant at the .05 level, it is followed by two asterisks; and if significant at the .01 level, it is followed by three asterisks.

VITA

Paul Herbert Engelmann

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE DEMAND FOR HOSPITAL SERVICES

Major Field: Economics

Biographical:

Personal Data: Born in St. Louis, Missouri, July 20, 1945, the son of Mr. and Mrs. Herbert L. Engelmann.

Education: Graduated from Webster Groves High School, Webster Groves, Missouri in June, 1963; received Bachelor of Arts degree in Business Administration and Economics from Drury College, Springfield, Missouri in May, 1967; received Master of Science degree in Economics from Oklahoma State University, Stillwater, Oklahoma in August, 1973; completed requirements for the Doctor of Philosophy degree at Oklahoma State University, Stillwater, Oklahoma in May, 1976.

Professional Experience: National Defense Education Act Graduate Fellowship, Oklahoma State University, 1967-1970; graduate teaching assistant, 1970-1971; research assistant, Oklahoma Employment Security Commission, Oklahoma City, Oklahoma, 1971; Assistant Professor, Central Missouri State University, Warrensburg, Missouri, 1971 - present.