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Patient Characteristics, Hospital Characteristics, and Hospital Use

Kong-Kyun Ro

What would be the usefulness of the economics of consumption in a study of the consumption of services where consumer ignorance is large and the nature of the product poorly understood? What would be the influence on consumption of the usual choice-conditioning factors, such as demographic factors, socioeconomic factors, taste variables, and prices, in a supplier-dominated industry?[1] Would it be desirable or necessary to reverse the emphasis from demand to supply in order to investigate the consumption of such a product? This paper is an attempt to answer these questions by proposing a model and testing its usefulness with empirical evidence from the hospital industry.

In the hospital industry, consumers are pictured as making few or no choices because they depend entirely on the judgment of experts as to the desirability and the nature of the product they buy, and they cannot buy the product even if they are willing to pay for it unless

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[1] On the choice-conditioning factors, see R. P. Mack, "Economics of Consumption," in B. F. Haley, ed., *A Survey of Contemporary Economics*, Homewood, Illinois, R. D. Irwin, Inc., 1952, pp. 49–63.

physicians authorize the purchase. The medical profession has promoted the idea that, given one's medical condition, the type and amount of hospital services provided are dictated by the "technological imperatives." Any variations in hospital use which are not explained by the differences in patients' medical conditions are attributed to the differences in the medical philosophies of the attending physicians and to "extramedical" factors such as age and sex of the patient.

Recent studies, however, have revealed two sets of systematic relationships—one between the patterns of hospital use and the socioeconomic characteristics of patients and the other between hospital use and hospital characteristics.[2] Partly in an attempt to explain the above relationships and partly as a separate theoretical development two distinct theories of economics of consumption of hospital services have emerged.

One theory postulates that hospital use is determined through the interaction between patients and doctors. A physician is described as treating a whole patient as a person, not a disease. Accordingly, personal and situational factors, in addition to medical conditions, are taken into consideration by doctors. These extramedical factors resemble the usual choice-conditioning factors listed in economics of consumption. The only departure from the traditional theory of con-

[2] There is a burgeoning literature on the relationship between hospital use and patient characteristics. Extensive references are provided in *Hospital Utilization Studies: Selected References Annotated,* U. S. Department of Health, Education and Welfare, 1962. U. S. Public Health Services also periodically publish the results of surveys on the subject through the National Center for Health Statistics Series. The most relevant issues are Series 13, numbers 1 to 3, and Series 10, numbers 20 and 30, *Vital and Health Statistics,* National Center for Health Statistics, U. S. Public Health Services, Department of Health, Education and Welfare. The other well-known surveys in the field are those by the Health Information Foundation—National Opinion Research Center; O. W. Anderson and J. J. Feldman, *Family Medical Costs and Voluntary Health Insurance: A Nationwide Survey,* New York, McGraw-Hill Book Company, 1956; O. W. Anderson, P. Colette, and J. J. Feldman, *Changes in Family Medical Care Expenditures and Voluntary Health Insurance: A Five-year Resurvey,* Cambridge, Harvard University Press, 1963; and R. Andersen and O. W. Anderson, *A Decade of Health Services,* Chicago, University of Chicago Press, 1967.

The relationship between hospital characteristics and hospital use has been studied in C. G. Skinner, "Hospitals and Allied Institutions," in W. J. McNerney, *Hospital and Medical Economics,* Chicago, Hospital Research and Education Trust, 1962, chapter 43; and D. C. Riedel, and T. B. Fitzpatrick, *Patterns of Patient Care,* Ann Arbor, University of Michigan, 1964, chapter 2.

sumer behavior is that it is the doctor who purchases the product on behalf of the consumer as an agent with "power of attorney" and that it is the responses of physicians to the choice-conditioning factors, not those of consumers themselves, that determine the consumption of hospital services.

The other theory is that economics of consumption has no role in explaining hospital use. Production of hospital services is envisioned as largely determined by technological imperatives and productive facilities available as well as institutional characteristics of individual hospitals. Consumers come into the picture only because their medical conditions dictate the product-mix of individual hospitals, but their wishes and expectations do not affect hospital use. The physician plays the pivotal role of the production manager who, using his knowledge of technology, combines factors of production to produce the "cure" of disease. In other words, given patients' medical conditions and technology, the physicians' responses to the environmental characteristics of individual hospitals determine the patterns of hospital use.

The model proposed is based on an integration of the two theories. Consumption of hospital services is hypothesized as a composite effect of the joint interaction among physicians, patients, and hospitals. The direct interaction is envisioned as taking place between physicians and patients. Hospital characteristics come into the picture as a factor influencing this interaction. The medical condition and socioeconomic background of a patient shape his expectations and wishes concerning hospital use. In the process of transmitting these, the patient reformulates them according to his attending physician's responses and the environmental characteristics of the hospital to which he is admitted. As for the doctor, his response is conditioned by his professional and personal background.

FORMULATION OF THE MODEL

Outline of the Model

In order to make the model operational, it is simplified and formalized as follows. The amount and type of hospital services provided are determined by the responses of physicians to the medical condition of patients, the socioeconomic characteristics of patients, the institutional environment of individual hospitals, and the interaction between patient characteristics and hospital characteristics. Four relationships constitute the basis of the model.

$$\bar{C} = \phi(M) \qquad (1{:}0)$$

$$P = F_i(X_1 \ldots X_n),\ U \qquad (2{:}0)$$

$$H = F_j(Y_1 \ldots Y_n),\ U \qquad (3{:}0)$$

$$C - \bar{C} = \sum_i \frac{\partial C}{\partial X_i} X_i + \sum_j \frac{\partial C}{\partial Y_j} Y_j + \sum_{ij} \frac{\partial^2 C}{\partial X_i Y_j} X_i Y_j \qquad (4{:}0)$$

where

$\bar{C}$ = the standard hospital use prescribed for illness M as "technologically" determined;
P = deviations from $\bar{C}$ caused by physicians' responses to patient characteristics;
H = deviations from $\bar{C}$ caused by physicians' responses to hospital characteristics;
X_i = patient characteristics;
Y_j = hospital characteristics;
C = total hospital use by patients with illness M;
F_i, F_j = behavioral relationships;
ϕ = a technology coefficient;
U = error term to make relationships stochastic.

The consumption of hospital services is measured by three indices: number of days hospitalized; weighted number of services received; and amount of the hospital bill. M, the medical condition, is represented by the final diagnosis recorded at the time of a patient's discharge from the hospital.

Patient characteristics are represented by six categories of variables:

X_1 = a vector of the demographic factors—age, sex, and race;
X_2 = income;
X_3 = method of payment;
X_4 = availability of substitutes for hospital care (as represented by proxy variables);
X_5 = cost of time spent hospitalized (as expressed by proxy variables);
X_6 = taste factors (as represented by proxy variables).

Hospital characteristics are also represented by six categories of variables:

Y_1 = peculiarities of individual hospitals (as expressed by dummy variables);
Y_2 = availability of hospital beds (as expressed by occupancy rate and the number of beds);
Y_3 = comprehensiveness of care provided (as expressed by weighted number of facilities and programs available);
Y_4 = availability of substitutes for inpatient care (as expressed by the existence or absence of an outpatient clinic and an organized home care program);
Y_5 = training activities of hospital (as expressed by the presence or absence of a graduate medical training program and a nursing school);
Y_6 = labor-capital ratio (as represented by proxy variables).

Some Problems in Applying the Data to the Model

In this model, the hospitals are depicted as producing the "cure" of diseases and illnesses using various factors of production operating under a given technology. (Training and research activities of hospitals are not discussed here.) It is assumed that, for each category of illness, there is a prescribed method of treatment, a method of producing the "cure." Thus, there is a production function for each "product," and the selection of a particular combination of factors of production, as expressed by the amount and type of hospital services provided, is determined by the physicians' responses to patient characteristics and hospital characteristics.

In measuring consumption of hospital care, therefore, a method had to be devised to measure, on a uniform scale, types and amounts of hospital services produced and simultaneously consumed. This necessitated formulating an output measure for the hospital industry. Hospital output is, however, an elusive concept difficult to define and measure.[3] Accordingly, although the proposed model takes the cure of disease as the conceptual unit of consumption, three input measures are taken as proxy variables for output.[4]

In a study of economics of consumption in the hospital industry, the use of input as the unit of consumption has this justification. Since consumers know little of the product they buy, they do not generate a demand for hospital care with a well-defined output, but instead in input terms, such as days of hospitalization, physicians' visits, specific procedures, etc. Furthermore, the three units of consumption adopted in this study—days of hospitalization, weighted number of services, and hospital bill—have traditionally enjoyed widespread acceptance,

[3] Of all the issues raised at a conference of experts, the problem of defining and measuring the product of the health industry was recorded to be most elusive and frustrating. See A. R. Somers and H. M. Somers, "A Program for Research in Health Economics," a paper prepared for a conference of experts, October 29, 1965, Brookings Institution, in U.S. Public Health Service Publication No. 947, Health Economics Series No. 7, January 1967, pp. 37–39.

[4] There are two positions regarding the output of a physician. Griliches argues that the doctor produces a "cure" and therefore a transaction unit should be the cure of a given disease. Gilbert, on the other hand, argues that the doctor produces an office visit, which should be the output measure. I take Griliches's position conceptually, but in measuring output, input variables are used. See Z. Griliches, "Notes on the Measurement of Price and Quality Changes," in *Models of Income Determinations,* Studies in Income and Wealth, Volume 28, Princeton, Princeton University Press for NBER, 1964, pp. 399–403; and M. Gilbert, "The Problem of Quality Changes and Index Numbers," *Monthly Labor Review,* September 1961, pp. 994–95.

and measure different aspects of consumption.[5] Thus, used together, they present a composite picture of hospital use.

Given each category of disease, ϕ in equation (1:0) purports to show the amount and type of hospital use technologically required to cure it. It cannot, however, be interpreted strictly as a technology coefficient, for there is a broad area where individual judgment is exercised in producing the cure within each technologically prescribed method of treatment. This is what the medical profession calls the justifiable differences in medical philosophies of physicians.[6]

As a technology coefficient, ϕ also has a limited applicability because of the problems of classification of "medical conditions." First, what constitutes medical conditions and what extramedical or personal situations is subject to interpretation. Second, how far the classification of diseases should be carried out poses a problem. On the one hand, a case can be made for treating every patient as having a different disease with a different medical requirement. In this case, ϕ as a technology coefficient loses its usual meaning because a new coefficient would have to be discovered for each new product. On the other hand, if classification is too broad, what appears to be the tolerance range in coefficients is in fact the difference in coefficients necessitated by producing different products.

In this study, for convenience and because of data restrictions, all cases are grouped into thirty categories of diseases following the International Code of Diseases Classification. Each category is further divided into four groups: surgical, nonsurgical, single diagnosis, and multiple diagnosis. Our technology coefficient, then, provides the standard (the mean value of) hospital use for one of the 120 groups thus classified.

In estimating the behavioral relationships behind F_i and F_j, the greatest handicap is the lack of information about physician characteristics. F_i purports to show physicians' responses to patient characteristics (X_i), and F_j, to hospital characteristics (Y_j). But even for

[5] Historically, these have been used as a basis to define and measure medical progress, as reflected in the changing pattern of hospital care and the cost behavior of the hospital industry. For a comprehensive list of indices and measures of hospital use, see T. B. Fitzpatrick and D. C. Riedel, "Some General Comments on Methods of Studying Hospital Use," *Inquiry*, 1, 1964, p. 50.

[6] Once it is established that the understanding and practice of the "technological imperatives" do not necessarily lead to identical methods of treatment by individual physicians, what constitutes the quality of care is subject to individual judgment. See A. Donabedian, "Evaluating the Quality of Medical Care," Part 2, *Milbank Memorial Fund Quarterly*, 44, 1966, p. 166.

identical X_i and Y_j, it has been hypothesized that physicians' responses would vary. Since no data about physicians are available, hospital dummy variables are inserted instead. To the extent that physicians in the same hospital share common backgrounds and medical philosophies, hospital dummy variables would show the variations in physicians' responses attributable to variations in characteristics of physicians.

In equation (4:0), the interaction term $(X_i\ Y_j)$ is included because the model hypothesizes systematic relationships between some patient characteristics and some hospital characteristics. The problem of intercorrelation between the predictors is seen to exist because hospital characteristics influence the interaction between physicians and patients, and also because patients with certain socioeconomic backgrounds seek hospitals with certain characteristics by choosing doctors who have staff privileges in the hospitals to which they want to be admitted. Introducing the interaction terms is not expected to solve the complex three-way relationships hypothesized, in particular those due to lack of information about physicians' characteristics. The interaction terms are inserted in the hope that they may provide new insight into which variables interact and how.

Coverage

The subjects studied consisted of twenty-two hospitals in the Pittsburgh area and 9,000 patients admitted to these hospitals during 1963. The available data relating to the hospital characteristics include numbers of beds, occupancy rates, types of programs offered and facilities available, medical and nursing education programs, and financial data. Data relating to patient characteristics include demographic and socioeconomic variables and those from medical records (such as diagnoses), numbers and types of services received, numbers and types of operations, if any, amounts of hospital bills, sources of payment of the bills, types of insurance coverage, if any, et cetera.

The data were collected by Blue Cross of Western Pennsylvania. The principal method of analysis is the least-squares single regression in various forms and its variants, such as the two-stage estimation procedure.

RESULTS

Hospital Characteristics and Hospital Use

As expected, hospital characteristics more successfully explain the variations in hospital use when unadjusted measures are used than

when the measures adjusted for diagnoses are used. This indicates a systematic relationship between the diagnosis-mix of an individual hospital and its characteristics as represented by these variables (see Table 5-1).

Differences in the characteristics of individual hospitals affect the patterns of special services provided and the hospital charges billed to patients more than does the length of stay of the patients. This is to be expected because the different medical philosophies of individual hospitals are more likely to be evident in patterns of care and price policy than in length of stay. This idea is supported by other regressions. Interhospital differences in hospital use are greatest when hospital use is measured by the weighted number of services, less when it is measured by hospital charges, and least when it is measured by length of stay.

Substitution of outpatient care and, to a lesser extent, (organized) home care for inpatient care takes place when these substitutes are available. Patients treated at hospitals which have outpatient clinics were hospitalized for shorter periods, received fewer services, and were charged less for inpatient care than those treated at hospitals without outpatient clinic facilities. This indicates that doctors who have staff privileges at hospitals which adhere to the concept of integrated care, providing intensive care, intermediate care, ambulatory care, and home care, do in fact substitute outpatient care for inpatient care at the diagnostic and convalescent stages of the patient's illness.

Patients admitted to hospitals which have graduate medical training programs receive significantly more hospital care—however measured—than those admitted to hospitals without such programs. For the most part, postgraduate medical training is carried out by larger hospitals with more comprehensive facilities. (The correlation coefficient between the number of beds and the weighted number of facilities is 0.66.) The greater use of hospital care by the patients in teaching hospitals may, therefore, be the result of these hospitals having more serious cases. To the extent that adjusting for differences in diagnoses failed to take into account the different medical requirements of patients, a positive relationship between the presence of the training programs and hospital use could be partly attributable to the differences in case-mix. A similar observation can be made about the significant positive relationship found between the weighted number of facilities of a hospital and hospital use by patients.

The presence of an accredited nursing school operated by the hospital appears to have different effects on hospital use from that of a

TABLE 5-1

Hospital Characteristics and Hospital Use, Adjusted for Differences in Diagnoses (n = 8986) Double Log

Hospital Characteristics	Length of Stay, Adjusted		Total Services, Adjusted		Total Bill, Adjusted	
	b Coefficient	Standard Error	*b* Coefficient	Standard Error	*b* Coefficient	Standard Error
Occupancy rate	−0.1507	0.0953	0.0421	0.0855	−0.0441	0.0838
Number of facilities, weighted	0.2969[b]	0.0549	0.4589[b]	0.0493	0.2358[b]	0.0483
Presence of intern program	0.1519[b]	0.0406	0.0493	0.0364	0.1068[b]	0.0357
Presence of residency program	0.1424[b]	0.0395	0.1362[b]	0.0355	0.2167[b]	0.0348
Presence of nursing school	−0.0485	0.0339	0.0913[b]	0.0305	−0.0804[b]	0.0399
Employees per bed	−0.2849[b]	0.0824	0.2284[b]	0.0740	−0.0175	0.0725
Presence of home-care program	−0.1375[b]	0.0224	−0.0534[b]	0.0201	0.0324	0.0197
Presence of outpatient clinic	−0.2462[b]	0.0561	−0.2668[b]	0.0503	−0.1874[b]	0.0493
a-constant	−1.1446		−1.7218		−1.1367	
Multiple R	0.11327		0.19356		0.12200	
R-SQ	0.01283[b]	(F = 14.6)	0.03747[b]	(F = 43.7)	0.01488[b]	(F = 17.0)
Adjusted R-SQ	0.01195	(DF = 8978)	0.03661	(DF = 8978)	0.01401	(DF = 8978)

[a] Significant at the 5 per cent level.

[b] Significant at the 1 per cent level.

graduate medical program. Whereas patients in hospitals with medical training programs stayed longer, received more special services, and paid more than those in hospitals without these programs, patients in hospitals with nursing schools stayed significantly shorter periods of time and were billed less, but received a greater number of services for given illnesses than those in hospitals without nursing schools. This may be because all the hospitals (nine of twenty-two in the sample) with nursing schools have residency and internship programs, but not vice versa. Just as hospitals with medical training programs are usually larger and more comprehensive than those lacking such programs, the hospitals with nursing schools are larger than those without them. (Hospitals with nursing schools had an average of 444 beds; those without one but with medical training programs, 190 beds; those without either, 178 beds. The mean weighted numbers of facilities of the above three types of hospitals were 45, 44, and 36, respectively.)

The distinctive patterns of patient care in larger hospitals with more comprehensive facilities seem to result in their patients receiving relatively more service-intensive and less time-consuming care. (The correlation coefficient between the weighted number of facilities and the number of special services, adjusted for diagnoses, is 0.102.) It appears that patients in hospitals with nursing schools are billed less for given episodes of illnesses because the savings realized from receiving daily hotel-type services for shorter stays are greater than the extra costs of the greater number of services received during the patient's stay.

Patients at hospitals with higher staffing ratios (employees per bed with occupancy held constant) are more likely to receive service-intensive care than time-consuming care. This conclusion is reached from the fact that patients at hospitals with high staffing ratios are hospitalized for significantly shorter periods of time for given illnesses than those at hospitals with low staffing ratios, but they receive greater numbers of special services.

The service-intensive care provided by hospitals with high staffing ratios was to be expected from the usual association between input mix and output mix. To the extent that the number of employees per bed represents the labor-capital ratio, the more employees per bed a hospital has, the more labor-intensive goods it is expected to produce. Since hospitals are a service industry, labor-intensive goods denote service-intensive care, that is, more things are done to each patient and less reliance is placed on the natural healing process.

To the extent that a higher staffing ratio is regarded as a desirable characteristic of a hospital, patients from higher socioeconomic fami-

lies will be attracted to such hospitals, as will doctors with better qualifications. (The correlation coefficient between employees per bed and the family income of the patient is 0.11.) To inquire whether such doctor-patient interaction takes place, and if so, what effect such interactions have on hospital use, an interaction term was formed between the number of employees per bed and an income variable, and its effects on hospital use were examined. The results, however, were not enlightening.

The variables selected to represent hospital characteristics appear to have been well chosen. Regression analysis of the effects on hospital use of hospital dummy variables shows significant interhospital differences in hospital use, but in terms of explaining variations in hospital use among individual patients, the twenty-one hospital dummy variables are about as successful as ten variables representing hospital characteristics.

Patient Characteristics and Hospital Use

Patient characteristics as represented by fifteen to seventeen variables have much more success in explaining the variations in hospital use by individual patients than hospital characteristics as represented by eight variables. (The new R^2 range is 0.187 to 0.207 for unadjusted hospital use measures; 0.031 to 0.051 for the adjusted measures. See Tables 5-2 and 5-3.) This seems to be attributable to the fact that demographic and socioeconomic characteristics of individual patients as represented by fifteen to seventeen variables are more important in shaping the basis of doctor-patient interactions, and thereby in determining the amount and type of hospital care provided individual patients, than hospital characteristics. Since our model hypothesizes that hospital use is determined by doctor-patient interactions, patient characteristics that reflect patients' attitudes and expectations are expected to influence those interactions in a more important way than environmental and institutional factors (as represented by hospital characteristics) within which these interactions take place.

Turning to the separate effects on hospital use of specific patient characteristics, the most obvious and important ones are those of demographic variables. As expected, each patient age category received a greater amount of hospital care than all younger patient categories, no matter how hospital use was measured. The differences in hospital use by age are smaller when the adjusted (for diagnoses) measures of the amount of hospital care are used than when unadjusted measures are used. This is to be expected: older patients in general have more

TABLE 5-2

Patient Characteristics and Hospital Use, Unadjusted for Differences in Diagnoses (n = 8986) Double Log

	Length of Stay, Unadjusted		Total Services, Unadjusted		Total Bill, Unadjusted	
Patient Characteristics	b Coefficient	SE	b Coefficient	SE	b Coefficient	SE
Income	−0.0387	0.0234	−0.0310	0.0240	−0.0200	0.0208
Education[c]	0.0889[b]	0.0203	0.0099	0.0208	0.0243	0.0184
Race composition[d]	−0.0182[b]	0.0053	−0.0065	0.0054	−0.0084	0.0047
Method of payment						
Patient	—	—	—	—	—	—
Service (free)	0.0723[b]	0.0165	0.1252[b]	0.0170	0.0836[b]	0.0150
Blue Cross	0.0438[b]	0.0131	0.0841[b]	0.0135	0.0467[b]	0.0117
Commercial insurance	0.0422[b]	0.0157	0.0711[b]	0.0162	0.0355[a]	0.0139
Government	0.1595[b]	0.0252	0.0741[b]	0.0259	0.1009[b]	0.0226
Unpaid or writeoff	0.0956[b]	0.0253	0.1364[b]	0.0260	0.0903[b]	0.0225
Employment status						
Unemployed or not stated	—	—	—	—	—	—
Employed	0.0103	0.0102	0.0715[b]	0.0105	0.0075	0.0091
Living arrangement						
Living with others	—	—	—	—	—	—
Living alone	0.0448[b]	0.0124	0.0098	0.0128	0.0191	0.0110

(continued)

(TABLE 5-2 concluded)

Room accommodation						
Ward	—	—	—	—	—	—
Semiprivate	—	—	—	—	0.0779[b]	0.0083
Private	—	—	—	—	0.1082[b]	0.0126
Age						
0–19 years	−0.4751[b]	0.0132	−0.4278[b]	0.0136	−0.4208[b]	0.0118
20–44 years	−0.2982[b]	0.0123	−0.3533[b]	0.0126	−0.2597[b]	0.0110
45–64 years	−0.0871	0.0127	−0.1025[b]	0.0130	−0.0821[b]	0.0113
65+ years	—	—	—	—	—	—
Race						
White	−0.0187	0.0125	−0.0438[b]	0.0128	−0.0271[a]	0.0111
Nonwhite	—	—	—	—	—	—
Sex						
Male	−0.0000	0.0086	0.0403[b]	0.0088	0.0034	0.0077
Female	—	—	—	—	—	—
a-constant	1.1153		1.2418		2.6357	
R-SQ	0.20315[b]	(F = 152.5)	0.18810[b]	(F = 138.6)	0.20829[b]	(F = 138.5)
Adjusted R-SQ	0.20182	(DF = 8971)	0.18675	(DF = 8971)	0.20679	(DF = 8969)

[a] Significant at the 5 per cent level.

[b] Significant at the 1 per cent level.

[c] Per cent of population with less than eight years of schooling reported in census tract.

[d] Per cent of nonwhite population reported in census tract.

TABLE 5-3

Patient Characteristics and Hospital Use, Adjusted for Differences in Diagnoses (n = 8986) Double Log

Patient Characteristics	Length of Stay, Adjusted		Total Services, Adjusted		Total Bill, Adjusted	
	b Coefficient	SE	b Coefficient	SE	b Coefficient	SE
Income	−0.0447[a]	0.0214	−0.0498[a]	0.0196	−0.0224	0.0188
Education[c]	0.0738[b]	0.0186	0.0075	0.0170	0.0196	0.0167
Race composition[d]	−0.0114[a]	0.0048	−0.0045	0.0044	−0.0019	0.0042
Method of payment						
Patient	—	—	—	—	—	—
Service (free)	0.0268	0.0151	0.0076[b]	0.0139	0.0308[a]	0.0136
Blue Cross	0.0082	0.0120	−0.0090	0.0110	0.0127	0.0106
Commercial insurance	0.0233	0.0144	0.0037	0.0132	0.0158	0.0127
Government	0.0914[b]	0.0231	0.0634[b]	0.0212	0.0442[a]	0.0205
Unpaid or writeoff	0.0481[a]	0.0232	0.0588[b]	0.0212	0.0398	0.0205
Employment status						
Unemployed or not stated	—	—	—	—	—	—
Employed	−0.0215[a]	0.0094	0.0039	0.0086	−0.0167[a]	0.0082
Living arrangement						
Living with others	—	—	—	—	—	—
Living alone	0.0242[a]	0.0114	−0.0119	0.0104	0.0041	0.0100

(continued)

(TABLE 5-3 concluded)

Room accommodation						
Ward	—	—	—	—	—	—
Semiprivate	—	—	—	—	0.0400[b]	0.0076
Private	—	—	—	—	0.0933[b]	0.0114
Age						
0–19 years	−0.1742[b]	0.0121	−0.1265[b]	0.0111	−0.1672[b]	0.0107
20–44 years	−0.0806[b]	0.0113	−0.0520[b]	0.0103	−0.0819[b]	0.0099
45–64 years	−0.0375[b]	0.0116	−0.0145	0.0106	−0.0362[b]	−0.0102
65+ years	—	—	—	—	—	—
Race						
White	−0.0032	0.0114	−0.0193	0.0104	−0.0111	0.0100
Nonwhite	—	—	—	—	—	—
Sex						
Male	−0.0466[b]	0.0079	−0.0061	0.0072	−0.0289[b]	0.0070
Female	—	—	—	—	—	—
a-constant	0.1205		0.1587		0.0412	
R-SQ	0.04574[b]	(F = 28.7)	0.03265[b]	(F = 20.2)	0.05312[b]	(F = 29.6)
Adjusted R-SQ	0.04415	(DF = 8971)	0.03103	(DF = 8971)	0.05132	(DF = 8969)

[a] Significant at 5 per cent level.

[b] Significant at 1 per cent level.

[c] Per cent of population with less than eight years of schooling reported in census tract.

[d] Per cent of nonwhite population reported in census tract.

serious illnesses than younger patients; to the extent to which adjusting for diagnoses eliminates the differences in hospital use due to differences in types of illnesses in different age groups, age differences in hospital use would diminish when adjusted measures are used.

The *b* coefficients of the sex variable show that proportionately more female patients are treated for less serious illnesses, but when treated for the same illnesses, they stay hospitalized longer, receive greater numbers of special services, and are charged more than male patients.

As expected, childbearing and other exclusively female conditions appear to be the principal reason more women are treated for less serious illnesses. Female patients whose principal diagnoses were listed as "delivery without complications" stayed, on the average, 5.7 days, compared with 9.1 days for all female patients, and these patients accounted for 19 per cent of all female patients discharged from hospitals. When the average lengths of stay are compared between sexes after the so-called female illnesses are excluded, female patients stay hospitalized about the same lengths of time (10.4 days) as male patients (10.3 days).

As for the variations in hospital use by race, whether the measures of hospital use are adjusted for differences in diagnoses or not, nonwhite patients stay longer, receive greater numbers of special services, and are charged more than white patients. The causes of this are difficult to theorize about because race and socioeconomic variables are intertwined in such a complex manner as to make the job of disentanglement very difficult. Not only is it readily assumed that proportionately more nonwhite patients are from families of low incomes, but also socioeconomic variables exert different influences on hospital use among whites and nonwhites.

There are significant differences in hospital use for given illnesses depending upon who pays the major portion of the hospital bill. When ranked from the greatest amount of use of hospital care to the least, the four major categories of patients by source of payment can be listed as government, free services, insurance, and patient. If the cure of an episode of illness is considered a transaction unit, the above variations in hospital use by method of payment can be interpreted as the result of the operation of price effect, because the order of ranking according to the relative amount of hospital use roughly corresponds, in reverse order, to that of the relative amount of out-of-pocket expenses incurred by the patient.

This, however, should not be explained away as simply a reflection of the price sensitivity of hospital use. The patient category as classi-

fied by method of payment may be related systematically to other factors, such as income, living arrangement, and employment status, and therefore a part of the difference in hospital use by method of payment may be attributable to these other factors.

The following list presents the correlation matrix among method of payment, employment status, and living arrangement:

	Employed	*Living Alone*
Patient	−.059	.031
Blue Cross	.105	−.085
Free service	−.180	.074
Government	−.088	.153

(The correlation coefficients are all statistically significant.) It is interesting to note that positive correlations with "employment" accompany negative correlations with "living alone."

For example, patients whose principal source of payment for hospital bills is themselves are likely to be unemployed and to live alone at home, while Blue Cross patients are likely to be employed and to live with someone else. Seen in this way, to the extent that the variables representing employment status and living arrangement failed to hold their effects on hospital use constant, "free service" and "government" patients may have used greater amounts of hospital care because they are likely to be unemployed and living alone at home.

The opportunity cost of time as represented by employment status has proved to be a choice-conditioning factor in hospital use. In an attempt to minimize the cost of time hospitalized, patients who are currently employed seek and succeed in receiving service-intensive care and thereby shorten the lengths of time they are hospitalized for given illnesses.

Since the employment status variable divides all patients into two categories only—those whose earnings foregone are nonzero and those whose earnings foregone are zero—a continuous variable representing the relative cost of time among those employed and those not employed is needed for a further examination of its effects on hospital use. The income variable in the context of the present analysis meets this need reasonably well, for the following reasons. First, the method-of-payment variable, which reflects the amount of out-of-pocket expenses regardless of size of hospital charges, neutralizes to a substantial extent the usual income effects operating through budget constraints. Second, to some extent the variable representing education severs the usual connection between income and taste.

The theory that, when method of payment, education, and the "cultural" factor are used as control variables, our income measure represents the cost of time can also conveniently explain the negative relationship between income and hospital use. Since it is hypothesized that hospital services are normal goods in terms of income elasticity of demand, and also because past studies show that high-income people use more hospital care than low-income people, the opposite result obtained in our study may be explained as the case where income measure represents mainly the cost of time. However, this leaves unresolved the important question of what the usual income effects on the consumption of hospital care are.

The hypothesis that, in the convalescent stage of illness, patients substitute general nursing care for inpatient hospital care if such care is available at home is supported by the relationship shown between the living-arrangment variable and hospital use. Those living alone seek and receive time-consuming care and thereby receive fewer special services and stay longer than those who have someone to look after them at home.

Interactions between Hospital Characteristics and Patient Characteristics, and Their Effects on Hospital Use

So far, we have explored two sets of relationships separately—one between patient characteristics and hospital use and the other between hospital characteristics and hospital use. The results indicate systematic variations in hospital use according to some of the variables representing patient characteristics and some of those representing hospital characteristics. This leaves the following question unresolved. Is the revealed relationship between *patient* characteristics and hospital use a reflection of different medical philosophies practiced by individual hospitals whose distinct modes of practice attract patients with distinct characteristics?

Looking at the relations from the other side, is the revealed relationship between *hospital* characteristics and hospital use attributable to the fact that patients at hospitals with different characteristics have different sets of expectations and demands? In this case, variations in hospital use by hospital characteristics merely reflect the responses to these different expectations and demands of patients.

Our hypothesis is that the answers to both questions are affirmative. Patients with certain characteristics choose hospitals with certain characteristics, and therefore patient and hospital characteristics are inter-

related in their effects on hospital use. In analyzing the factors influencing hospital use, hospital characteristics could be treated as a reflection of patient characteristics, and vice versa. To test this hypothesis, various interaction terms between the variables representing patient characteristics and those for hospital characteristics were formed, and their effects on use examined.

Of the interaction terms whose relationships with hospital use were analyzed, several seemed to provide new insights; these are presented in Tables 5-4 and 5-5.

The data support the theory that hospital and patient characteristics are significantly interrelated. The correlation matrix constructed between thirteen variables representing patient characteristics and nine variables representing hospital characteristics shows that, with a few exceptions, correlations are statistically significant (Table 5-6).

A comparison of adjusted R^2's (the proportions of the variations in hospital use explained by the variables inserted in the regressions) among various regressions lends additional support to this theory. When variables representing hospital characteristics and those representing patient characteristics are combined and inserted into a single regression equation, there is only small improvement in the adjusted R^2, from 0.204 for the regression with variables representing patient characteristics only, and 0.035 for the regression with those representing hospital characteristics only, to 0.232.

More important, forming interaction terms between the two sets of variables enables us to sharpen our point of inquiry about specific hypotheses on the various relationships between individual variables chosen and hospital use. For example, our inquiry on how the method of payment affects hospital use is aided by forming an interaction term between the variables representing method of payment and occupancy rate. This enables us to ask what kind of hospital services consumers receive when they have a strong incentive to minimize hospital charges and hospitals are pressed for empty beds.

As shown by their b coefficients, the interaction terms between the variables representing the method of payment and occupancy rate have the same effects on hospital use as those of the method of payment variables alone. As before, patients whose hospital bills are paid by the government use the most hospital care, those whose costs are borne by individual hospitals as free services are next, insurance-paid patients are third, and patients who pay their own bills use the least hospital care.

What is gained by the interaction terms is that the differences in

TABLE 5-4

Interaction Terms Between Patient Characteristics and Hospital Characteristics, and Their Relationships to Hospital Use, Unadjusted for Differences in Diagnoses (n = 8986) Double Log

Patient and Hospital Characteristics	Length of Stay, Unadjusted		Total Services, Unadjusted		Total Bill, Unadjusted	
	b Coefficient	SE	b Coefficient	SE	b Coefficient	SE
Method of payment × occupancy rate						
Patient × occupancy	—	—	—	—	—	—
Service × occupancy	0.0958[b]	0.0198	0.1459[b]	0.0202	0.0436[a]	0.0176
Blue Cross × occupancy	0.0590[b]	0.0152	0.1104[b]	0.0155	0.0578[b]	0.0134
Commercial × occupancy	0.0607[b]	0.0189	0.1140[b]	0.0193	0.0437[b]	0.0168
Other insurance × occupancy	0.0788[b]	0.0334	0.0169	0.0341	−0.0018	0.0296
Government × occupancy	0.1716[b]	0.0294	0.0605[a]	0.0301	0.0360	0.0261
Other × occupancy	0.1074[b]	0.0298	0.1435[b]	0.0304	0.0463	0.0264
Beds × occupancy	0.1569[b]	0.0204	0.0981[b]	0.0208	0.2004[b]	0.0181
Personnel per bed × income	−0.0640[b]	0.0172	−0.0097	0.0195	0.0148	0.0170
Occupancy × outpatient clinic × living with others	−0.0472[b]	0.0123	−0.0825[b]	0.0126	−0.0180	0.0109

(continued)

(TABLE 5-4 concluded)

Race × room accommodation	−0.0037	0.0154	−0.0140	0.0168	−0.0169	0.0145
Internship × residency × nursing	−0.0051	0.0108	0.0595[b]	0.0110	−0.0309[b]	0.0096
Income × employed	−0.0000	0.0000	0.0000[b]	0.0000	0.0000	0.0000
Race × per cent nonwhite	0.0005	0.0019	0.0071[b]	0.0020	0.0029	0.0017
Age						
0–19 years	—	—	—	—	—	—
20–44 years	0.1752[b]	0.0105	0.0733[b]	0.0110	0.1678[b]	0.0035
45–64 years	0.3829[b]	0.0117	0.3098[b]	0.0120	0.3458[b]	0.0104
65+ years	0.4712[b]	0.0131	0.4039[b]	0.0134	0.4297[b]	0.0115
Male	0.0031	0.0084	0.0453[b]	0.0086	−0.0046	0.0075
a-constant	0.4188		0.4874		1.6646	
Multiple R	0.45781		0.45121		0.46060	
R-SQ	0.20959[b]	(F = 139.9)	0.20359[b]	(F = 134.9)	0.21215[b]	(F = 142.1)
Adjusted R-SQ	0.20809	(DF = 8964)	0.20208		0.21065	

[a] Significant at the 5 per cent level.
[b] Significant at the 1 per cent level.

TABLE 5-5

Interaction Terms Between Patient Characteristics and Hospital Characteristics, and Their Relationships to Hospital Use, Adjusted for Differences in Diagnoses (n = 8986) Double Log

Patient and Hospital Characteristics	Length of Stay, Adjusted		Total Services, Adjusted		Total Bill, Adjusted	
	b Coefficient	SE	b Coefficient	SE	b Coefficient	SE
Method of payment × occupancy rate						
Patient × occupancy	—	—	—	—	—	—
Service × occupancy	0.0354	0.0182	0.0839[b]	0.0165	−0.0031	0.0159
Blue Cross × occupancy	0.0134	0.0139	0.0065	0.0126	0.0119	0.0122
Commercial × occupancy	0.0357[a]	0.0174	0.0342[a]	0.0157	0.0172	0.0152
Other insurance × occupancy	0.0354	0.0307	−0.0333	0.0278	−0.0203	0.0269
Government × occupancy	0.0926[b]	0.0270	0.0596[a]	0.0245	−0.0102	0.0237
Other × occupancy	0.0515	0.0273	0.0515[a]	0.0247	0.0024	0.0239
Beds × occupancy	0.1178[b]	0.0187	0.1553[b]	0.0170	0.1725[b]	0.0164
Personnel per bed × income	−0.0697[b]	0.0176	−0.0195	0.0159	0.0062	0.0154
Occupancy × outpatient clinic × living with others	−0.0104	0.0113	−0.0234[a]	0.0102	0.0104	0.0099

(continued)

(TABLE 5-5 concluded)

Race × room accommodation	0.0175	0.0150	0.0273[a]	0.0136	0.0046	0.0132
Internship × residency × nursing	−0.0087	0.0097	0.0246[b]	0.0090	−0.0304[b]	0.0087
Income × employed	−0.0000[b]	0.0000	−0.0000	0.0000	−0.0000	0.0000
Race × per cent nonwhite	−0.0029	−1.6277	−0.0003	0.0016	−0.0004	0.0015
Age						
0–19 years	—	—	—	—	—	—
20–44 years	0.0919[b]	0.0099	0.0694[b]	0.0090	0.0850[b]	0.0087
45–64 years	0.1343[b]	0.0107	0.0973[b]	0.0097	0.1337[b]	0.0094
65+ years	0.1749[b]	0.0120	0.1115[b]	0.0109	0.1764[b]	0.0105
Male	−0.0452[b]	0.0077	−0.0052	0.0070	−0.0353[b]	0.0068
a-constant	−0.1953		−0.4399		−0.6158	
Multiple R	0.22512		0.23725		0.24500	
R-SQ	0.05068[b]	(F = 28.2)	0.05629[b]	(F = 31.5)	0.06002[b]	(F = 33.7)
Adjusted R-SQ	0.04888	(DF = 8969)	0.05450		0.05824	

[a] Significant at the 5 per cent level.

[b] Significant at the 1 per cent level.

TABLE 5-6

Correlation Matrix: Relationships Between Patient Characteristics and Hospital Characteristics ($n = 8986$)

Patient and Hospital Characteristics	Occupancy Rate	Facilities Weighted	Intern Program	Presence of Nursing School	Employees per Bed	Payroll Total Expenses	Number of Personnel	Presence of Home-care Program	Presence of Outpatient Clinic
Income	0.0738	0.0001	0.0008	0.0315	0.1145	−0.0221	0.0003	0.1001	−0.0730
Housing[a]	−0.0520	0.0505	0.0065	0.0036	−0.0628	0.0548	−0.0020	−0.0689	0.0860
Education[b]	−0.0854	0.0350	−0.0077	−0.0317	−0.1198	0.0121	−0.0171	−0.1100	0.1001
Racial composition[c]	−0.0930	0.0739	−0.0324	0.0097	0.0757	0.0282	−0.0204	0.0338	0.0693
Race									
White = 1	0.1314	−0.0943	0.0474	0.0157	−0.0668	−0.0194	−0.0101	−0.0777	−0.0667
Method of payment									
Free service dummy	−0.0820	0.0675	−0.0196	0.0016	0.0713	0.0501	0.0280	−0.0134	0.0584
Patient dummy	0.0128	−0.0049	−0.0102	−0.0136	0.0196	0.0026	0.0042	−0.0022	−0.0140
Blue Cross dummy	0.0240	−0.0363	−0.0022	−0.0249	−0.0151	−0.0346	−0.0386	0.0515	−0.0115
Commercial insurance dummy	0.0007	−0.0534	−0.0279	−0.0308	−0.0274	−0.0212	−0.0057	−0.0331	−0.0442
Government dummy	0.0103	−0.0033	0.0173	0.0229	−0.0167	−0.0089	0.0180	−0.0152	−0.0155
Marital status									
Married = 1	−0.0376	0.0307	−0.0024	−0.0140	0.0006	0.0057	0.0099	0.0422	−0.0158
Employment status									
Employed = 1	0.0940	0.0295	0.0988	0.1091	−0.0243	0.0243	0.0247	0.0156	−0.0283
Living arrangement									
Living alone = 1	0.0293	0.0333	0.0516	0.0701	0.0024	0.0213	0.0147	−0.0184	0.0022

Note: $r \geq .0206$, significant at .05 confidence level.
$r \geq .0272$, significant at .01 confidence level.

[a] Per cent of substandard units reported in census tract.

[b] Per cent of population with less than eight years of schooling reported in census tract.

[c] Per cent of nonwhite population reported in census tract.

hospital use according to who pays the major portion of the hospital bill are crystallized. Note that in most cases the magnitudes of *b* coefficients which show the differences in the amount of hospital use from that by those who pay the bill themselves have increased.

This indicates that, to the extent that the amount of out-of-pocket expenses incurred by each patient represents the price of the cure of an episode of illness, the price sensitivity of hospital use increases when the hospital has fewer empty beds. It has been pointed out, however, that the relationship between the method-of-payment variable and hospital use cannot be simply interpreted as price elasticity of demand for hospital care because of intercorrelation between method-of-payment variables and those representing income, living arrangements, employment status, et cetera. Unfortunately, forming interaction terms between the method-of-payment variables and those other variables and examining their effects on hospital use yielded no new useful information.

Previously, the opportunity cost of time was measured by whether the patient was currently employed. Since this employment status variable divides all patients into two categories only, an interaction term was formed between employment status and income variables to examine how the costs of time among those who are employed, as measured by their family incomes, affected hospital use. As expected, the regression analyses showed that the greater the opportunity cost of time as measured by the interaction term, the shorter the length of stay.

In addition, since the housewife is not employed and yet her cost of time is not zero in terms of housework foregone, another interaction term was formed among the variables representing income, employment status, and sex of the patient. Regressing this interaction term against hospital use showed that high-income male patients currently employed seek hospitalization for the treatment of more serious illnesses than others, but that, once hospitalized, they stay for shorter periods of time for given illnesses by seeking service-intensive care to minimize the cost of time hospitalized. (This regression is not reproduced here.)

It has been hypothesized that the extent to which the costs of time affect hospital use depends on out-of-pocket expenses. In testing this hypothesis we have gained little enlightenment through the use of interaction terms such as that between the cost-of-time variable and the per cent of the hospital bill paid by the patient. Therefore, in analyzing the effect of the cost of time on hospital use, the out-of-pocket expenses are represented by the dummy variables showing the method of

payment, and they are used as control variables, thus holding their effect on hospital use constant.

It has been shown that, for given illnesses, patients living alone stay hospitalized longer than those living with others at home, indicating that in the convalescent stage of illness patients substitute hospital care for general nursing care if such care is available at home. In order to determine the extent to which such substitutions take place and how this affects inpatient hospital use, an interaction term was formed among the variables representing occupancy rate, the presence of an outpatient clinic, and living arrangements.

This enabled us to ask whether—if the hospital has an outpatient clinic which facilitates ambulatory treatment, the patient has somebody to take care of him at home, and the hospital is pressed for empty beds—the doctors will discharge the patient as early as possible to alleviate the bed shortage by substituting inpatient care for outpatient care at outpatient clinics and at home. The result shows that such substitutions do take place under these conditions and, therefore, the patient stays a shorter period of time and a relatively lower number of special services are administered while he is hospitalized. This is a case where doctor-patient interaction reinforces the expectations and motivations of both.

It has been shown that patients treated at hospitals which have graduate medical training programs receive more hospital care than those treated at hospitals without such programs and that patients in hospitals with nursing schools receive more service-intensive care and stay shorter periods than those in hospitals without nursing schools. In order to investigate the relationship between training programs and hospital use by the patients, an interaction term was formed among variables representing the presence of an internship program, a residency program, and a nursing school, and its effects on hospital use was examined. The result indicates that the patients at the hospitals with all three training programs receive service-intensive care and stay shorter periods for given illnesses.

An explanation for this finding was sought in the hypothesis that teaching hospitals are usually prestigious and that they attract doctors and patients with certain characteristics. Therefore, the fact that the patients in these hospitals receive a different type and amount of care may simply reflect specific types of doctor-patient interactions. This hypothesis was tested by forming an interaction term between the variables representing the presence of medical training programs and the family incomes of patients. This crude measure of doctor-patient

interactions yielded no new insight into the validity of the hypothesis. (In a similar vein, the distinct patterns of patient care in hospitals with different numbers of facilities were examined by forming an interaction term between income and weighted number of facilities. The results again provided no new insights.)

Another hypothesis tested was that more special services are provided to patients in the hospitals with training programs because more tests are conducted there to establish normal results for teaching purposes. Since most of these tests for teaching purposes are administered to ward patients, this hypothesis was tested by forming an interaction term between the variables representing the presence of graduate medical education programs, race, and ward room accommodation and then by examining its effects on hospital use. The results showed that nonwhite patients in wards receive a significantly greater number of special services than white patients in semiprivate or private rooms.

It has been observed that nonwhite patients use more hospital care than white patients, but there is a negative relationship between racial composition of neighborhood and hospital use. This conflicting result poses a problem of interpretation. Is this conflicting relationship attributable to the difference in the neighborhood effect and the racial effect on hospital use?

One may point out that nonwhites in predominantly white neighborhoods behave differently from those in predominantly nonwhite neighborhoods. Not much use can be made of this theory here because, in view of the prevailing racial pattern of residential districts, it is doubtful that the racial-composition variable has succeeded in isolating neighborhood effects on hospital use. (The data show that the correlation coefficient between the race variable white $= 1$ and the racial-composition variable is 0.58.) On the other hand, the fact that both race and racial-composition variables have significant b coefficients in terms of t ratios indicates that the multicollinearity problem is not serious. Analysis of an interaction term formed between race and racial-composition variables and its relationship to hospital use showed that nonwhite patients from predominantly nonwhite neighborhoods were hospitalized for more serious illnesses than white patients, but for given illness they stayed shorter periods and paid less than white patients in white neighborhoods. This confirms our a priori reasoning about behavior patterns of the nonwhite patients, many of whom probably are lower on the socioeconomic scale.

The reasons for this observed relationship of the interaction term between race and racial composition vis-à-vis hospital use were sought

in a possible correlation between race and income and that between race and education, and in their effects on hospital use. Income and education were examined because they are the most obvious causes of differences in the behavior patterns of white and nonwhite patients.

The correlation matrix presented below indicates that, as expected, white patients have higher incomes, more education, and better jobs than nonwhite patients.

	Race (white = 1; nonwhite = 0)
Income	.266
Education	
(the lack of)	−.365
Occupation	.139

(Education is represented by the per cent of the population twenty-five years old or older who had less than eight years of schooling; occupation, by the per cent of the population who had managerial or professional jobs.) However, when an interaction term is formed between race and income and another between race and education, and their effects on hospital use are examined, no new insights are obtained.

The occupancy rate was negatively related to hospital use. This relationship cannot be taken seriously, however, because it is insignificant. It seems to be attributable to the fact that occupancy rate is an unsatisfactory variable to represent the relative scarcity of empty beds because occupancy rate is systematically related to number of beds regardless of the pressure of demand for these beds. (The correlation coefficient between the number of beds and occupancy rate is 0.19.) Thus, when the availability of beds is represented by an interaction term between occupancy rate and the number of beds in other regressions, it has a positive and significant relationship with all six measures of hospital use. This provides one more piece of evidence that an increase in supply of beds will, ceteris paribus, result in some increase in hospital use.