THE ECONOMICS OF HOSPITAL UTILIZATION UNDER INSURANCE
Some Preliminary Findings

Irving Leveson and Regina Reibstein, New York City Department of Health

For the last fifteen years the analysis of medical markets has been dominated by "Roemer's Law," the proposition that the supply of hospital beds determines the demand for inpatient care. There is a great deal of evidence that the number of patient days of care is roughly proportional to the number of short-term general hospital beds.

A number of hypotheses as to the nature of the relationship are considered and their theoretical and empirical bases are explored. The material presented here represents an abbreviated portion of the new empirical evidence which is developed. A complete copy of the paper is available upon request.

Most of the available evidence relates to market-wide changes. We were concerned that this might mask important developments taking place at the individual hospital level. The approach chosen was to examine hospitals undergoing expansion in order to determine why some hospitals are able to fill their beds and others are not. The sample consists of all cases of hospitals with an initial size of 400 beds or more which increased in size by 50 beds or more during the 1960's. The findings presented apply to 39 hospitals in Standard Metropolitan Statistical Areas operated by nonprofit corporations. This category excludes hospitals controlled by religious organizations. Six observations were excluded because of missing data. The mean size of hospitals was 593 beds and the mean increase 125 beds.

The Model and the Data

The dependent variable is the elasticity of census with respect to beds. The percentage change in census per percentage change in beds is generally given by $\eta = \frac{\Delta C}{\Delta B} / \frac{C}{B}$, so that the elasticity is equal to the ratio of the marginal occupancy rate to the average occupancy rate. A value of 1 indicates that the occupancy rate of the added beds is equal to the occupancy rate prior to expansion. In order to avoid distortions due to unequal expansions, the arc is actually used.

The arc elasticity of census with respect to beds is calculated from the period two years prior to expansion until two years after construction of the new beds is completed. The possibility of going until the third year was rejected because the mean change in census from the second to the third year was only one percent for all hospitals, there was more of an opportunity for extraneous factors to have an influence and the sample size would have been reduced. The mean elasticity for 39 nonprofit corporation hospitals was .95 and the standard deviation was .44. The variables and hypotheses follow. Except as noted, the area specific variables apply to SMSA's.

Price

The design of this study is especially suited to determining whether price is important at all. The extensiveness of insurance coverage, absence of consumer information and role of technical factors in the medical care decisions make it necessary to first raise the question in this form. Hospitals undergoing expansion are generally a close substitute for other hospitals in their area so that the effect of price on demand for the individual hospital can be expected to be far greater than the effect of price on the quantity of medical care consumed.

The measure used is the difference between the average annual percentage change in the hospital's expense per patient day from two years before construction until two years after and the average change for similar hospitals in the community. The geographic unit is the self-designated city reported in the American Hospital Association's "Guide Issues." Price changes during construction are heavily influenced by the cost of paying off the mortgage and therefore reflect the lavishness of the project, construction costs, interest rates, and the extent of philanthropy and thus can be considered exogenous to bed utilization. A greater increase in costs is expected to result in a lower elasticity of census with respect to beds.

An alternative formulation treats expense per patient day of the study hospital and of comparable hospitals in the area as separate variables. The term $b(X_1-X_2)$ is replaced by $b_1X_1-b_2X_2$ in order to determine if $b_1>b_2$. One hypothesis is that consumers considering care at the study hospital will have only very incomplete information as to prices at other hospitals and as a result will respond less sensitively to changes in prices at other hospitals. Another possibility is that new facilities bear a disproportionate share of the adjustment to proportional cost increases in the system as a whole. This would appear as a greater negative response to a hospital's own price increase than the positive response to the increase in the average price at other hospitals. Such behavior could arise because of the effects of habit formation on the ability of a new hospital to attract either patients or staff.

Insurance

The higher the level of hospital insurance coverage in the area, the more readily beds are expected to be filled since the average out-of-pocket cost for the patient will tend to be lower. Surgical insurance reduces the cost of treatment and is expected to be associated with greater utilization as well. The percentage of the population covered by hospital and surgical insurance were each constructed by a)estimating enrollment in private insurance in the SMSA for the population under age 65, adjusting the state average for the average difference between large SMSA's and other areas derived from a regression of city size on insurance coverage across states, b) adding in average coverage for the aged, and c) adding in coverage for the indigent by applying the SMSA's proportion of the state's poor to state Medicaid enrollment. Aggregates of states were used where SMSA's were located in more than one state.

The correlation between hospital and surgical enrollment rates in the nonprofit corporation samples was .84. Results are shown using hospital coverage alone. In an alternative specification, surgical coverage is used as a measure of the percentage of the population with both hospital and surgical coverage and a separate variable for the excess of hospital coverage over surgical coverage is used as a measure of the proportion of the population with hospital coverage only.

These variables test the actual effect of insurance coverage on utilization. A test was also made of the effects of expectations on the part of the hospitals as to the impact of insurance. If hospitals expected Medicare and Medicaid to make it easier to fill beds but in fact beds were not filled then we would expect to find lower elasticities among hospitals for which the decision to construct was made after these programs were anticipated. Hospitals completed in 1969 or later are assumed to have been committed in 1965 or later and are coded one in a dummy variable to measure the effect of expectations.

Hypotheses Relating to Beds and Population

Level and Change in Hospital Size. Hospitals would be more likely to reduce occupancy if increasing size were associated with greater specialization and less likely if increasing size presented a greater opportunity to average risks. The greater the expansion in beds, the lower the elasticity if there are long- or short-run difficulties in absorption of additional beds. The absolute size and change in beds are used.

Number and Growth in Beds Per Thousand Population. Beds per capita in the SMSA provide a direct test of whether there is a tendency for marginal occupancy rates to be lower where bed supply is greatest. The Community's (AHA) rate of growth of beds per capita during the period two years before construction until two years after was expected to be negatively associated with elasticity if there is a tendency toward saturation.

Population and Population Density. A larger population, given density and beds per capita, is expected to result in greater occupancy because of the larger potential market. A denser population for a given population size is expected to be associated with higher occupancy because of the proximity to markets. Data are in millions and thousands per square mile respectively.

Population Growth. The larger the percentage change in population from 1960 to 1970, the greater the demand for hospital care. High rates of growth may be anticipated, however. Past growth may be a measure of expected future growth. Hospitals may be more likely to build beds which will not be filled immediately in areas with rapid expected growth in future demand, resulting in lower elasticities.

Physician Availability

The larger the number of physicians in the area per hospital bed (1970), the greater the ease of staffing. In an alternative formulation, the impact of specialists per bed and general practitioners per bed is examined separately in view of recent evidence that specialist supply tends to be associated with greater hospitalization and general practitioner supply with less. Physician availability is also measured by the percentage growth in physicians per bed in the state between 1963 and 1970. State data are used deliberately in order to avoid an identification problem stemming from the effect of the hospital expansion itself on the demand for physicians in the SMSA.

Teaching Status

Dummy variables were created for three teaching categories: medical school affiliation, limited graduate training and non-teaching. The choice of which variable to omit was made by entering the dummy variables in a stepwise regression in order to select that combination of dummy variable categories which maximized the contribution to R^2.

Findings

The results of the linear ordinary least squares regression across 39 nonprofit corporation hospitals are shown in Table 1. The coefficient of determination is .35. The only variable which is significant at a high level is price. The simple R^2 between price and the elasticity is .09.

A 1 percent increase in the average annual rate of price change from two years before construction until two years after is associated with a .052 decrease in the elasticity of census with respect to beds. The standard deviation of price is 4.1 so that a one standard deviation variation in price is associated with a .21 point difference in elasticity or approximately one half a standard deviation. The coefficient of the hospital insurance variable is sizable and in the expected direction but not statistically significant. The coefficient of beds per capita is positive contrary to expectations, but is not significant while bed growth is far from significant.

In the second equation, the price components are examined separately. The hospital's own price change is highly significant with a coefficient of .06 and a standard error of .023. However, the price change of other hospitals, while positive, has a coefficient of only .03 and a t ratio less than one. While there is no significant difference between the absolute values of the coefficients of the price variables, the size of the difference is substantial.

The third equation examines the alternative formulation of insurance coverage. The coefficient and significance levels for the combination of hospital and surgical coverage are similar to the values for the hospital coverage variable. The variable for additional hospital coverage over surgical has no effect.

Finally, the effects of general practitioners per bed and specialists per bed are examined separately. There is still no significant effect of physician availability in the area on the change in occupancy of hospitals which expand.

A test was made to determine whether there is any tendency for hospitals with a low elasticity to have smaller price increases in the future relative to other hospitals as a means of raising occupancy. In this analysis the elasticity is the independent variable and price the dependent variable. The average and change in price relative to other hospitals is taken from the year two years after hospital expansion, the final date for the elasticity, until the fourth year after expansion. Capacity changes took place early enough for the follow-up period data to be available in 32 of the hospitals. The relationship was estimated as

$$P = -5.40 + \underset{(2.27)}{4.15}\eta \qquad R^2 = .10.$$

The hypothesis is accepted at the .05 level on a one sided test. The coefficient is substantial indicating an 8 percent price difference after two years for a one percent difference in elasticity. The earlier estimates indicate that a 4 percent per year difference in price could be expected to have a large effect on utilization. We have only looked at price differences which are realized, of course, and an infrequent use of price adjustment could arise from a tendency for other hospitals to follow price changes, together with low response of market demand to price.

Discussion

The evidence of the importance of price as a modifier of the response of census to beds is consistent with the findings of studies which depend heavily on insurance as a price determinant. The finding that a one standard deviation change in price is associated with a half standard deviation change in the utilization elasticity invites comparison with Martin Feldstein's evidence that half of the response of census to beds is a pure availability effect and half a price effect.[1] The interpretation is very different, however.

Less than one-tenth of the variation in the response of census to beds among hospitals is associated with price. The mean price change is -.2, virtually zero. The mean elasticity of census with respect to beds, the ratio of the marginal to the average occupancy rate is .95, essentially indistinguishable from 1. While we find evidence that price is an important variable even when represented by hospital expenses per patient day, the tendency is for the average response of census to beds to hover around one even after price effects are removed.

Price may also play some role in adjustments to excess capacity, as the post construction comparisons suggest. But it must be noted that when a 500 bed hospital with 90 percent occupancy expands to 600 beds, the difference between an elasticity of .5 and an elasticity of 1 is one of whether the hospital will end up with an occupancy rate of 82.5 percent or of 90 percent, and differences of that magnitude are able to persist. We have found no evidence to cast doubt on the proposition that when hospital beds expand the marginal occupancy rate is about equal to the average.

An expanding hospital may pull some patients from each of several others, and we have made no tests of the effects of hospital capacity changes in the occupancy rate in the entire market. To some extent this was tested in reverse by looking for effects of changes in capacity of other hospitals on use of the study hospitals. The lack of significant effect is consistent with Sander Kellman's finding that capacity changes have only a small effect on occupancy.[2] The lack of a negative impact of beds per capita also is indicative of little or no tendency for the marginal occupancy rate to be declining in response to capacity changes.

The findings appear to provide further support for the notion of a systematic relationship of census to beds. Proper interpretation requires consideration of explanations beyond the scope of this part of the analysis.

FOOTNOTES

1. Martin Feldstein, "Hospital Cost Inflation, A Study of Nonprofit Price Dynamics," American Economic Review, 61, No. 5 (December 1971), pp. 853-872.

2. Sander Kellman, "Utilization of and Investment in U.S. Short-Term Hospitals," unpublished Ph.D. dissertation, University of Michigan, 1970.

TABLE 1

REGRESSION ANALYSIS OF ARC ELASTICITY OF CENSUS WITH RESPECT TO BEDS

	Basic Equation	Price Components	Insurance Components	Physician Components
Intercept	-1.610	-1.286	-1.371	-1.612
Price Difference	- .053 (.021)		- .052 (.020)	- .053 (.023)
Hospital Insurance	.022 (.014)	.022 (.014)		.022 (.015)
Expected Insurance	.234 (.200)	.261 (.179)	.186 (.178)	.235 (.207)
Size of Hospital	.001 (.001)	.001 (.001)	.001 (.001)	.001 (.001)
Change in Hospital Size	- .001 (.001)	** **	- .001 (.001)	- .001 (.001)
Beds per Capita	.136 (.084)	.124 (.080)	.145 (.082)	.137 (.087)
Bed Growth	- .020 (.037)	- .022 (.023)	- .025 (.034)	- .020 (.038)
Population	.010 (.065)	*	*	.010 (.068)
Density	.032 (.057)	.028 (.055)	.040 (.056)	.032 (.062)
Population Growth	.009 (.009)	.008 (.009)	.011 (.009)	.009 (.009)
Physicians per Bed	.878 (.863)	- .671 (.858)	- .971 (.857)	
Physician per Bed Growth	8.320 (6.874)	8.586 (6.198)	7.588 (6.145)	8.343 (7.078)
Medical School Affiliation	- .200 (.216)	- .195 (.212)	- .462 (.275)	- .201 (.224)
Graduate Affiliation			- .258 (.258)	.314 (.281)
Non-teaching Hospital	.314 (.274)	.188 (.294)		
Hospital Price		- .060 (.023)		
Area Price		.030 (.037)		
Hospital and Surgical Insurance			.023 (.014)	
Hospital Insurance Only			.013 (.022)	
General Practitioners per Bed				- .979 (4.011)
Specialists per Bed				- .865 (1.003)
R^2	.350	.362	.358	.350

NOTE: Standard errors are in parentheses.

* Did not enter under F = .001.

** Less than .0005