THE IMPACT OF PHYSICIAN CHARACTERISTICS IN CONDITIONAL CHOICE MODELS FOR HOSPITAL CARE

Lawton R. Burns, Ph.D., MBA
Department of Management & Policy
and
School of Public Administration & Policy
College of Business & Public Administration
University of Arizona
Tucson, Arizona 85721
(602) 621-1950

Douglas R. Wholey, Ph.D.
Department of Social & Decision Sciences
Carnegie Mellon University
Pittsburgh, Pennsylvania 15213
(412) 268-3228

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Abstract

Recent research has investigated the determinants of the specific hospitals to which patients are admitted. Data limitations have led researchers to examine the effects of patient and hospital characteristics while ignoring the role of physician characteristics. In this study we analyze the effects of all three sets of factors on hospital choice in the greater Phoenix area during 1989. Our results suggest that physician characteristics are strong determinants of hospital choice, accounting for much of the explained variation. Differences in hospital quality and cost, on the other hand, exert significant effects on hospital choice but explain relatively little variation.

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There has been a considerable amount of research on the factors influencing consumer choice of hospitals in local markets. Much of the early work examined spatial patterns of hospital utilization using variations of a gravity model.[1] More recently, researchers have employed conditional choice models to explain the patient's choice of one hospital over another.[2]

Due to a lack of data, this research has failed to examine the role of the physician in hospital choice. With the exception of emergency admissions and persons lacking a personal physician, patients and physicians are typically linked in the demand for hospital care. A patient chooses a physician who, in turn, selects the hospital to which the patient is admitted or strongly influences the patient's choice [Cohen and Lee (1985), Garnick, Luft, Robinson, and Tetreault (1987)]. Most studies recognize the omission of the physician's role as a potentially serious problem of model misspecification. Researchers may underestimate the importance of the physician or overestimate the importance of hospital characteristics in determining hospital selection. For example, Dranove et al. (1989) assert that admissions can be reasonably well predicted without physician data because physicians tend to practice near hospitals that patients prefer, not vice-versa. Luft et al. (1990) stress that hospital choice is influenced by variations in hospital quality and cost, even though their findings indicate that distance is the most important determinant.

This paper replicates and extends previous work [Garnick et al. (1989), Dranove et al. (1989), Luft et al. (1990)] by examining the effects of physician as well as patient and hospital characteristics on hospital choice in the Phoenix market during 1989. We seek to determine

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[1] Representative studies here include Morrill and Earickson (1968), Morrill, Earickson, and Rees (1970), Roghmann and Zastowny (1979), and McGuirk and Porell (1984).

[2] These studies include Cohen and Lee (1985), Lee and Cohen (1985), Garnick, Lichtenberg, Phibbs et al. (1989), Luft, Garnick, Mark et al. (1990), and Phibbs, Mark, Luft et al. (1991).

whether the inclusion of physician variables improves the fit of these choice models and affects the estimates of the patient and hospital measures. The paper then re-evaluates the effects of these characteristics on hospital choice and examines their implications for current policy questions such as the dissemination of data on provider quality of care.

DETERMINANTS OF HOSPITAL CHOICE: MAJOR EMPIRICAL APPROACHES AND FINDINGS

Early studies of patient choice of hospitals utilized multiple regression techniques to estimate patient flows from small neighborhoods to hospitals located throughout the metropolitan area [Morrill and Earickson (1968), Roghmann and Zastowny (1979)]. Their results suggested that patient choice is characterized by "distance delay" (i.e., distance discourages utilization). Due to the spread of third-party insurance coverage, the time-price of travel was viewed as the salient cost to consumers rather than the money-price of hospital services. Many of these studies further revealed that the elasticity of the distance-utilization relationship was lower for larger, research-oriented hospitals. The distance decay hypothesis was reformulated as a "gravity model" in which the probability of selecting a hospital is positively related to its size and negatively related to its distance from the patient's home [Roghmann and Zastowny (1979)].

Recent studies have utilized conditional choice models that explicitly take into account competing hospitals that patients might select. The majority of studies have used linear approximations to transform the nonlinear choice model and have found support for the gravity model [Cohen and Lee (1985), Lee and Cohen (1985), Erickson and Finkler (1985), Folland (1984), McGuirk and Porell (1985), Dranove, White, and Wu (1989)]. Patient distance consistently exhibits the largest absolute coefficient and accounts for a majority of the explained variation in hospital selection. The scope (sophistication) of hospital services and the density of physicians around the hospital also exert some positive influence.

Garnick et al. (1989) demonstrate that maximum likelihood estimation techniques are preferable to the linear versions of the conditional choice model. Luft et al. (1990) and Phibbs et al. (1991) have utilized these techniques to examine hospital choice in the San Francisco Bay Area. They uncovered similar effects of distance and quality in shaping patient choice. For example, patients chose hospitals that are located nearby, are affiliated with a medical school, are heavily used by out-of-state residents, and have lower than expected death rates. They also reported that patients are more likely to choose hospitals with lower-than-expected charges.

There are no studies of physician choice among competing hospitals using such models. Researchers have instead asked physicians about their preferences for various hospital characteristics or examined their aggregate admitting patterns, reaching somewhat different conclusions. Studies of physicians' preferences suggest there is considerable overlap in the preferred hospital of patients and their physicians in seeking hospital care. Physicians' preferences for hospital characteristics include the quality of medical and nursing care, the range of services available, and the convenience to both the physician and patient [Okorafor (1983), Sheldon (1986), Muller and Bledsoe (1989)]. Studies of admitting patterns, on the other hand, indicate that physicians concentrate their admissions in large private hospitals which are located near their offices and which physicians have heavily utilized before [Gaffney and Glandon (1982), Burns, Wholey, and Huonker (1989), Burns and Wholey (forthcoming)].[3] These findings suggest that physician convenience (e.g., short travel distances, concentrated hospital practice, reliance on the same hospital) may allow little room for the patient's convenience or preferences. Patients have to travel to more distant hospitals when physicians concentrate their admissions in a few large hospitals [Burns et al. (1989)] and concentrate their offices in central business districts that surround hospitals [Morrill et al. (1970)].

These studies suggest that choice of hospital is shaped by characteristics of the physician as well as the patient and hospital. Lacking information on the admitting physician, researchers

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[3] None of these studies utilizes conditional choice models. Gaffney and Glandon describe the characteristics of the physician's primary hospital using data from an AMA survey of medical practice. Burns, Wholey, and Huonker use a two-stage tobit [Maddala (1983)] to estimate the number and percentage of a physician's patients that are admitted to a given hospital. Burns and Wholey use logistic and multiple regression to predict the withdrawl of a physician's admissions from a hospital and the change in practice share at a hospital over time.

have tested only hypotheses involving patient and hospital characteristics. This shortcoming is not serious if patient and physician preferences for hospital characteristics are either similar (they prefer the same hospital for the same reason) or orthogonal (they prefer the same hospital for different reasons). However, if their preferences conflict, then it becomes important to specify the impact of both patient and physician characteristics on hospital choice and determine whether physician interests outweigh those of the patient. This paper examines the effect of physician, patient, and hospital characteristics on hospital choice using hospital discharge data from one market. The next two sections describe the methods and results from our test, followed by a reassessment of the hypotheses and their implications for public policy.

METHODS

Data Sources

Patient discharge data from 1989 were obtained from the Arizona Department of Health Services. These data identify the admitting physician, hospital, and various characteristics of the patient (diagnoses, procedures, outcomes, charges, age, sex, and zipcode of residence). Physician data regarding zipcode of office location were obtained from the state medical association. Physician admission profiles at each hospital were derived by aggregating patient discharge data. Hospital data regarding ownership, bedsize, and medical school affiliation were gathered from the Annual Guide published by the American Hospital Association [AHA (1990)].

The state discharge data do not include hospitals with less than 50 beds, psychiatric facilities, or federal institutions. Such exclusions do not seriously distort our analyses, however. The vast majority of these hospitals are located outside the Phoenix market area; the remainder account for only 10% of admissions within the market area (see below).

Patient Conditions

We conducted our analyses for patients in each of six different diagnosis related groups (DRGs). The selection of diagnoses was based on several considerations:

1. A sufficient number of patients distributed across many hospitals to permit the analysis of hospital-level effects;
2. A sufficient number of patients originating from the zipcode areas serving as the hospital's market area;
3. A sufficient number of deaths to permit computation of hospital-specific adjusted mortality rates; and
4. A sample of both medical and surgical diagnoses similar to those studied by Garnick et al. (1989) and Luft et al. (1990) to permit comparisons.

Such considerations led us to utilize DRGs for four medical conditions (respiratory infection, acute myocardial infarction, atrial fibrillation, and gastrointestinal bleeding) and two surgical conditions (aorta repair or replacement, large bowel resection).

Definition of the Phoenix Hospital Market Area

Previous research has demonstrated that the Standard Metropolitan Statistical Area (SMSA) constitutes too narrow a definition of hospital market area [Morrisey, Sloan, and Valvona (1989)]. Following Elzinga and Hogarty (1973) and Garnick et al. (1989), we defined the Phoenix market area in terms of a hospital and patient cluster that minimized the percentage of residents leaving the area for hospital care ("outflows") and the percentage of admissions to area hospitals by patients from outside the area ("inflows"). Across the six diagnoses, the average inflow rate in the Phoenix market is ten percent; the average outflow rate is only four percent. These criteria expanded the size of the market beyond the SMSA to include much of the neighboring counties. Inflows and outflows are excluded from the analyses, as are patients transferred from other acute-care facilities. Table 1 lists the number of patients, patient zipcodes, patient deaths, hospitals, percent inflows, and percent outflows for each diagnosis in the market.

Conditional Logit Models

Conditional logit models are used to estimate the likelihood of one hospital being selected over others in the market area. Such models take into account not only the attributes of the hospital selected but also those of the hospitals not chosen. Assume that an individual in location i needs to use a hospital. The individual may be a physician whose office is located in a specific zipcode or a patient whose residence lies in that zipcode. Let K be the set of hospitals in the market from which the physician and/or patient may choose. Following McFadden's (1974) random utility approach, the probability of an individual physician or patient from location i choosing hospital j from the set K is

$$p_{ij} = \frac{\exp(\mathbf{X}_{ij}\,\mathbf{B})}{\Sigma_k \exp(\mathbf{X}_{ik}\,\mathbf{B})} \quad \text{, for all j in K}$$

where $\mathbf{X}_{ik}$ is a vector of observations on the explanatory variables associated with the alternatives, and **B** is an unknown vector of taste parameters [Judge, Griffiths, Hill, et al. (1985, p.770)]. Maximum likelihood procedures[4] are used to estimate the parameters for each independent variable.

Two features of the conditional logit models used here deserve further comment. First, the likelihood function does not include individual characteristics that are invariant across all of the hospital choices, such as physician specialty, patient age or insurance carrier. The effects of such invariant characteristics are differenced away in conditional logit models [McFadden (1980)]. While these models thus estimate a single utility function for all individuals (physicians or patients), they do not necessarily imply that all individuals have the same preferences. Individual characteristics may vary in importance as determinants of hospital choice depending on their interaction with specific hospital alternatives [cf. McFadden (1980)]. For example, elderly patients may be more sensitive to longer hospital distances than are younger patients (age x distance interaction).

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[4] Maximum likelihood estimates are derived using MLOGIT, a software package compatible with SAS. MLOGIT is distributed by Salford Systems, Del Mar, CA (619-582-7534).

Second, McFadden's conditional logit model assumes that the ratio of the probability of choosing one hospital to the probability of selecting another is unaffected by the number of alternative hospitals [Judge, Griffiths, Hill et al. (1985, p.771)]. The "independence of irrelevant alternatives" (IIA) assumption can be evaluated using a specification test described by Hausman and McFadden (1980) [cf. also McFadden (1980)]. The test compares estimated parameter and covariance matrices from the full choice set with a restricted choice set. Unfortunately, this test can fail for reasons other than IIA and can yield a negative test statistic.[5] For our analyses, we report the results from Hausman-McFadden specification test as well as the differences in parameter estimates between models using the full and restricted choice sets.

Independent Variables

Our analysis builds upon previous research using conditional logit models of patient choice [cf. Garnick et al. (1989), Luft et al. (1990), Phibbs et al. (1991)]. We have therefore followed similar methods of variable construction when possible, including case-mix adjusted measures of various hospital outcomes (mortality, charges). Our analysis also includes new measures describing the physician's proximity to and prior utilization of each hospital in the market area.

Case-mix Adjusted Hospital Outcome Measures. Following Luft et al. (1990), we calculated a case-mix adjusted Z-score for in-hospital mortality using state-wide data. This measure represents a rough indicator of hospital quality. We first used logistic regression to estimate the occurrence of mortality as a function of patient age, sex, presence of comorbidity, presence of secondary diagnoses in certain major diagnostic categories, and three dummy variables indicating admission from the emergency room and transfer from either another acute-care hospital or a skilled nursing facility. Next, we predicted the patient's death using

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[5] The difference between population covariance matrices formed by the deletion of one choice has to be non-negative definite, which results in a non-negative test statistic. Unfortunately, the difference between two estimated covariance matrices obtained in the same manner is not guaranteed to be non-negative definite, which can result in a negative test statistic.

probability values from the logistic regression and aggregated the actual and predicted deaths for each hospital within each DRG. We then used a binomial distribution to calculate the probabilities for the actual and expected number of deaths at the hospital in that DRG, subtracted these probabilities, and converted the difference score into a z-score by standardizing across all hospitals within that DRG. High (positive) values indicate worse than expected outcomes; low (negative) values indicate better than expected outcomes.

We calculated a second case-mix adjusted measure of hospital charges using ordinary least-squares regression. In addition to the variables mentioned above, the regression model included dummy variables denoting the payor category of the patient. Actual and expected charges were aggregated within each hospital and divided to yield a measure of hospital costliness. This measure was also converted into a z-score by standardizing across all hospitals within each DRG. High (positive) values indicate greater than expected charges; low (negative) values indicate lower than expected charges. Table 2 presents sample results for one condition.

Other Hospital Characteristics. Following Luft et al. (1990), we included two further indicators of quality: the number of out-of-state admissions to the hospital for the particular diagnosis, and a dummy variable denoting hospital affiliation with a medical school. The small number of hospitals in the Phoenix market forced us to limit the inclusion of additional hospital-level measures, such as ownership. While Luft et al. specified dummy variables for public and for-profit ownership, we included one dummy for nonprofit ownership because research suggests it is preferred by patients over the other two.

Physician and Patient Characteristics. Our analysis also incorporates several measures of the hospital's accessibility to both physicians and patients. First, using metropolitan zipcode maps, we calculated the straightline geographic distance (in miles) from the center of the zipcode in which the physician's office or patient's home was located to each hospital. While more precise estimates of distance can be computed using latitude/longitude data or time travel data, straightline measurements have been found to yield similar magnitudes for the estimated elasticity of distance [cf. McGuirk and Porell (1984, p.92)]. There was little evidence of collinearity between the physician and patient distance measures (average correlation = .14 across the six conditions).

Second, following a personal suggestion by Luft, we calculated the availability of physicians as the number of practitioners who admit patients and have offices within a five-mile radius of each hospital. This measure, similar to those used by Folland (1983) and Cohen and Lee (1985), serves as a proxy for the supply of local physicians with admitting privileges at each hospital. Holding other factors constant, hospitals with greater numbers of admitting physicians nearby will attract more patients [Folland (1983)].

Third, we measured the physician's prior utilization of each hospital by the number of patients he/she admitted in the same DRG during 1988. This measure captures the physician's past hospital preferences across all of his/her patients and their impact on present decisions regarding where to hospitalize a given patient.

For each of the six conditions studied, Table 3 presents the descriptive statistics for these independent variables. Following Garnick et al. (1989), we have excluded hospitals from the multivariate analyses for a given condition when they had few (less than 20) admissions. This accounts for the slightly lower number of hospitals reported in Table 3 vs. Table 1.

RESULTS

We estimated two conditional choice models for each condition. Model #1 specifies many of the effects analyzed by Garnick et al. (1989) and Luft et al. (1990): patient distance, indicators of hospital quality (adjusted mortality, out-of-state patients, medical school affiliation), hospital charges, and ownership. For this model we compute the likelihood ratio test, i.e., -2 times the difference in the log likelihood of the choice model compared to the equiprobable model. Model #2 adds the remaining variables of hospital accessibility to physicians and patients (office distance, physician availability, and prior utilization by the physician). For this model, we calculate the likelihood ratio test with the preceding model as the comparison. Our intention here is to assess the relative importance of physician variables in choice models that hitherto have examined quality and cost effects.

We estimated three variants of Model #2. All three (Models #2a, 2b, and 2c) include physician office distance. Model #2b adds physician availability, while Model #2c adds the physician's prior utilization. This procedure reflects our beliefs about the relative precision and utility of these measures. Physician office distance is a precise measure that captures important determinants of admitting patterns (e.g., time-costs/convenience). Physician availability, by contrast, has been used previously as a rough proxy for physician influence on the patient's choice of hospital (captured here more directly by office distance). It is included here to determine whether local supply exerts any effect net of individual-level characteristics. Prior utilization of the hospital is a potentially important indicator of physician convenience. We include it in only one model because of its resemblance to a lagged dependent variable.

Model #1. Table 4 presents the regression estimates from the first model. Following McFadden (1980), the coefficients can be interpreted as taste weights that increase the probability of a hospital's selection over others in the choice set. For both sets of conditions, the regression estimates support the effects of patient distance and hospital quality reported by Luft et al. (1990). Patient distance always exerts a significant ($p < .001$) negative effect on hospital choice: patients prefer hospitals closer to home. Measures of hospital quality exert fairly consistent positive effects. In four of the six conditions, patients choose hospitals that have lower than expected mortality rates. We find the expected positive coefficient for out-of-state cases in five of the six conditions, three of which are statistically significant ($p < .01$). As Luft et al. (1990, p. 2903) argue, hospitals with greater numbers of such patients are typically referral centers and enjoy a reputation that attracts patients. A third measure of hospital quality, medical school affiliation, positively influences choice in all six conditions ($p < .01$).[6]

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[6] We also estimated models that included bedsize in place of medical school affiliation. We did not include both measures in the same equation due to their strong association. Bedsize exerts a significant positive influence on hospital choice across all six conditions in Model #1.

The other measures exert less consistent effects. Adjusted charges has a significant negative effect on hospital choice for myocardial infarction patients, but positive effects for most other conditions. There is thus no evidence that patients select hospitals on the basis of low cost in this market. Nonprofit ownership has a significant positive influence on hospital choice in only two of the six conditions.

Overall, Model #1 constitutes a significant improvement over the equiprobable model in explaining hospital use patterns, as measured by the likelihood ratio statistic. Expressed as a percentage reduction in the model's log likelihood (pseudo R^2), Model #1 accounts for 27 to 40 percent of the variation, similar to results reported by Luft et al. (1990). However, while the majority of coefficients are significant, the variables are not equally powerful. Similar to Lee and Cohen (1985), we found that 90 percent of the explained variation in hospital choice across all six conditions is accounted for by patient distance when it is entered first in this model.

Model #2. The estimates in Model #2 illustrate the importance of physician variables (see Table 5). Hospital choice is consistently influenced by the proximity of the physician's office (Model #2a). The inclusion of this measure yields a sizeable decrease in the likelihood ratio statistic. Physician availability (Model #2b) exerts a significant positive effect on hospital choice in all six conditions but adds much less to the model's explanatory power. The physician's prior utilization of the hospital (Model #2c), on the other hand, exerts a strong positive effect on hospital choice in the four conditions where the model converged. The addition of this measure also significantly increases the explained variation in hospital choice.

The pattern of significant effects for the remaining variables resemble those reported in Model #1, although the parameter estimates fluctuate. The strong negative effect of patient distance persists even when we added the measures of physician distance and prior utilization. The adjusted mortality measure exhibits a significant negative impact on hospital choice in five conditions, while the number of out-of-state cases and medical school affiliation positively influence hospital choice in four conditions. Furthermore, there is little evidence that patients prefer lower-cost or nonprofit hospitals. We also investigated the interactive effect of individual characteristics (e.g., patient age, insurance carrier) with specific hospital alternatives (e.g., patient travel distance). The interaction terms were almost always insignificant.

Finally, we evaluated the IIA assumption by deleting one hospital from the choice set, re-estimating the model, and computing the Hausman-McFadden test statistic. Using Model #2a to illustrate the results, the test yielded nonsignificant chi-square values for two conditions (χ^2 = 9.1 for respiratory infection and 7.3 for large bowel resection, with seven d.f.) and a significant ($p < .01$) chi-square value for a third (χ^2 = 19.8 for gastrointestinal bleeding). Chi-square values for the remaining conditions were negative. We also computed the percentage change in the estimates between the full and restricted models (i.e., the average absolute value of differences in estimates divided by the average absolute value of estimates from the full model). The change in estimates was negligible for three conditions, with no change in sign or significance among the other three.[7] The evidence suggests that the IIA assumption holds for at least two of the six conditions (respiratory infection, large bowel resection).

DISCUSSION

We have attempted to contribute to research on conditional choice models for hospital care in two ways: by examining the impact of physician characteristics and by seeking to replicate recent findings in a market previously not studied. Our specific aims have been to assess whether the addition of physician characteristics improves the fit of these models and affects the estimates of other predictors. We are encouraged by the consistency of our findings with results obtained in other markets using similar models. While we have studied only one market containing 25 hospitals and examined data for only six diagnoses during one year, such consistency fosters greater confidence in the results and leads us to offer several conclusions.

The results from Model #1 replicate previous research evidence regarding the effects of patient and hospital characteristics on hospital choice. Consistent with the distance-decay

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[7] The change in estimates was 1.4% (respiratory infections), 21.7% (aorta repair), 9.1% (myocardial infarction), 0.2% (atrial fibrillation), 1.8% (large bowel resection), and 6.0% (gastrointestinal bleeding).

hypothesis, we find a strong negative influence of patient travel distance on hospital choice. Because hospital markets are fairly localized [cf. Garnick et al. (1987)], patients tend to select hospitals located near their homes. Consistent with the gravity model, we find a strong positive influence of hospital size on hospital choice. Finally, consistent with Garnick et al. (1989) and Luft et al. (1990), we find that choice is influenced by hospital quality, whether measured by risk-adjusted mortality rates, out-of-state volume (reputation), or medical school affiliation.

The results from Model #2 extend current research by specifying effects associated with the patient's physician. Our findings suggest that gravity attracts both the patient and the physician. Office proximity and prior utilization exert strong positive effects on hospital choice. The inclusion of these physician characteristics does not substantially alter the pattern of significant patient and hospital effects observed in Model #1 but does influence some of the parameter estimates (see below). The addition of physician characteristics often substantially improves the model's fit. Physician characteristics account for more of the explained variation in hospital choice than do patient and hospital factors in three conditions (respiratory infection, aorta repair, large bowel resection) and nearly as much variability in the other three. Indeed, patient distance, physician distance, and prior utilization constitute a powerful, parsimonious model of hospital choice.[8]

Gravity may not be the only force at work. The effects of the physician characteristics are consistent with consumer search and location models which emphasize incentives to select nearby sellers in order to minimize costs associated with travel and repeat purchases [cf. Satterthwaite (1979), Dranove et al. (1989)]. The literature on firm-specific human capital [cf. Becker (1975)] also suggests it is efficient for physicians to concentrate their hospital practice in one facility over time.[9] Historical reliance on one hospital enables physicians to develop consultative and referral relationships with colleagues, to become familiar with hospital staff and

[8] Other physician characteristics that might predict hospital choice include the presence of hospital-physician joint ventures and hospital-HMO contracts.

[9] We wish to thank our anonymous reviewers for pointing out this alternative argument.

routines, and thus to maximize their patient care time. The effects of office proximity and prior utilization are also consistent with repeat purchasing behavior models which emphasize brand loyalty and inertia [cf. Jeuland (1979), Kahn, Kalwani, and Morrison (1986)]. Recent evidence suggests that physicians remain loyal to those facilities that minimize the amount of travel time spent visiting patients and accomodate a large proportion of the physician's total admissions in the prior period [Burns and Wholey (forthcoming)]. Finally, the physician effects are also consistent with economists' views that physicians utilize hospital services in ways that maximize their own welfare, whether it be income, convenience, or leisure [cf. Pauly and Redisch (1973), Feldstein (1983), Eisenberg (1986, Chapter 2)]. We suggest that in weighing the costs and benefits regarding where to hospitalize a given patient, physicians consider the costs to themselves (e.g., office distance, familiarity with the hospital and its staff) as much or more than the costs to the patient (travel distance, hospital cost).

The strength of the physician effects is important, given recent findings that quality and cost shape hospital choice. We can suggest at least three alternative explanations for their prominence. First, physician distance and prior utilization are precisely defined using zipcode coordinates and hospital discharge data, whereas hospital quality is crudely measured by a combination of structural (medical school affiliation), processual (number of out-of-state cases), and outcome indicators (adjusted mortality rate).

Second, the measure of physician office distance may capture past decisions about hospital quality made by patients (e.g., physicians locate their offices near hospitals that patients prefer) and physicians (e.g., physicians select their primary hospital <u>before</u> choosing their office). It is impossible to evaluate this explanation without a two-stage model of office and hospital selection. The explanation is not consistent with our results, however. The addition of physician distance in Model #2a does not suppress the effects of adjusted mortality (average correlation = .01 across the six conditions) or out-of-state cases (average correlation = -.01) observed in Model #1, although it does weaken the impact of medical school affiliation (average correlation = -.20). The results thus offer no clear evidence that physicians locate near high-quality hospitals, but do suggest that physicians may locate in areas (e.g., business districts) where teaching hospitals are also situated.

We examined the potential endogeneity of physician office location by omitting from each physician's choice set the hospital located closest to his/her office (i.e., presumably the primary hospital) and then reestimating our models. We observed the same basic pattern of effects observed in Models #1 and # 2a: patient distance and office location are the most important determinants of hospital choice (results available from authors). While these results do not support the endogeneity argument, it is possible that physicians consider the quality of several hospitals and select an office location that permits easy access to more than one. More research is clearly needed on the determinants of office location and its responsiveness to differences (or changes) in hospital quality.

Third, the measure of the physician's prior utilization may also capture past decisions of hospital choice that consider hospital quality. Luft et al. (1990, p. 2905) make the similar argument that "[p]hysicians' experience with previous similar cases in a given hospital could help them to make judgements about the hospital's quality." Thus, a physician's continued use of a hospital can reflect both the quality of the hospital and its convenience. Because hospital quality is likely to change very slowly over time, its effect on hospital choice may also reflect the process of inertia.

This explanation cannot be tested with our research design. Our own results regarding prior utilization are somewhat equivocal. While the coefficients for two of our observed measures of quality, adjusted mortality and out-of-state cases, are not diminished by the inclusion of prior utilization (cf. Models #1 and #2c), the coefficients for medical school affiliation and adjusted charges shrink considerably. This may reflect physician preferences (i.e., past choices) for hospitals that expend greater resources on patient care and offer house staff coverage for patients. Taken together, the effect of prior utilization on current hospital choice and the effect of its inclusion on other parameter estimates suggest that unobserved attributes associated with quality may influence the selection of the hospital.[10]

Overall, however, our results suggest that while physicians and their patients may be sensitive to differences in hospital quality, considerations of convenience seem to exert a much stronger influence on hospital choice. Luft et al. (1990, p. 2905) reach a somewhat similar conclusion that hospital outcomes are relatively less important than distance. While they find it remarkable that quality has any effect at all on hospital choice, we find it remarkable that its effect is so weak. This finding does not appear to be due to a lack of comparative information on hospital performance. The study was conducted two years after the initial release of Medicare mortality data in a hospital market with marked competition for patients (e.g., the entrance of the Mayo Clinic in Scottsdale). Differences in hospital mortality rates appear to have only a marginal impact on patients' and physicians' choice of hospitals. In a recent survey, two-thirds of hospital chief executive officers stated that the Medicare mortality data released by the Health Care Financing Administration did not help consumers to make rational decisions about health care providers [Johnsson (1990)]. Physicians, too, may regard such data as meaningless or discount it heavily relative to their own knowledge and experience with the quality of area hospitals. In this light, recent federal efforts to promote consumerism by releasing Medicare mortality statistics may not have been effective. On the other hand, the data release may have a marginal impact by shifting patients away from the lowest-quality providers.[11]

Unfortunately, differences in hospital charges similarly fail to influence physicians' choices. Physicians may not be able to distinguish differences in charges to make cost-effective choices. Our data cannot test this possibility. Our data do support the alternative explanation that physicians weigh their own costs and convenience in making hospital selections. This

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[10] As one reviewer pointed out, the sensitivity of the medical school coefficient to the inclusion of prior utilization may reflect not only unobserved quality but also close linkages between teaching hospitals and their medical staffs, many of whom are likely to be hospital-based practitioners [Alexander, Morrisey, and Shortell (1986)].

[11] Personal communication from Hal Luft to the first author.

explanation suggests that if efforts by the federal government and third-party insurers to alter medical practice patterns are to succeed, they must consider their impacts on physician income and time. They must also recognize the time required to overcome the effects of inertia. Evidence suggests that physicians take 2-5 years to alter their admitting patterns [Sheldon (1986), Wholey and Burns (1991)]. Policy-makers should thus expect neither rapid nor major changes in medical practice patterns in the short term.

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TABLE 1

Number of Patients, Hospitals, Zipcodes, Inpatient Deaths, Patient Inflows and Outflows* - By Diagnosis Related Group

	Medical DRGs				Surgical DRGs	
	Respir-atory Infectn	Acute Myocard. Infarctn	Atrial Fibril-lation	Gastro-Intest. Bleedng	Aorta Repair/ Replace	Large Bowel Resectn
Hospital Market: Phoenix Area						
# Patients	1,187	3,126	2,537	2,111	1,116	2,345
# Hospitals	19	24	24	23	17	22
# Zipcodes	106	132	118	126	111	126
% Deaths	14.66	14.36	2.96	4.45	6.63	6.52
% Inflows	7.27	11.89	9.00	7.25	15.39	9.63
% Outflows	3.10	3.82	5.30	3.08	2.62	2.37

Note:

% Inflows is the percentage of patients admitted to hospitals in the market area who dwell outside of the area.

% Outflows is the percentage of patients dwelling within the market area who are admitted to hospitals outside the area.

TABLE 2

Case-Mix Adjusted Regression Models Predicting Hospital Mortality and Charges for Patients with Acute Myocardial Infarction

	Mortality		Charges	
	Coeff	St. Err	Coeff	St. Err
Intercept	-1.851	.108c	7186	580c
Sex (female)	.167	.083a	2	206
Age: Under 50	-2.113	.271c	2052	464c
50-59	-1.697	.184c	2170	421c
60-69	-.888	.115c	2451	321c
70-79	-.377	.100c	1692	292c
Admit from ER	-.015	.087	1132	208c
Transfer from Other Hospital	.304	.288	1898	671b
Transfer from SNF	-.913	.375b	-2190	718b
Presence of Endocrine Diagnoses	.514	.177b	697	531
Presence of Hematologic Diagnoses	-.632	.241b	1545	486b
Presence of Neurologic Diagnoses	1.583	.143c	986	468a
Presence of Circulatory Diagnoses	.853	.083c	2920	218c
Presence of Respiratory Diagnoses	.989	.151c	4927	492c
Presence of Digestive Diagnoses	-.332	.188	1493	408c
Presence of Genitourinary Diag.	1.429	.168c	2577	561c
Presence of Neoplasm Diagnoses	1.591	.452c	-1539	1554
Payer : Commercial Insurance			-162	500
HMO			-347	514
Medicare			-335	500
Self/Other			-1346	612a
N	6097		6096	
-2 Log Likelihood	4107			
Likelihood Ratio+	726/16c			
Pseudo R^2	.150			
R^2			.080	

a - $p < .05$
b - $p < .01$
c - $p < .001$

+ Compared to Equiprobable (Constant only) model

Table 3

Descriptive Statistics for Independent Variables:
Means (Standard Deviations)

	Medical Conditions				Surgical Conditions	
	Respiratory Infection	Acute Myocardial Infarction	Atrial Fibrillation	Gastro Intestinal Bleeding	Aorta Repair/ Replacement	Large Bowel Resection
Hospital Measures:						
Number of Hospitals	17	21	21	21	17	19
Adjusted Mortality Z-score	-0.50 (0.98)	-0.05 (0.97)	-0.33 (1.16)	0.09 (1.22)	-0.41 (1.20)	0.18 (0.98)
Out-of-State Cases	3.94 (5.35)	15.24(15.88)	11.95(19.55)	7.29(10.67)	5.59(10.28)	6.37(10.13)
% Medical School	0.29 (0.46)	0.24 (0.43)	0.24 (0.43)	0.24 (0.43)	0.29 (0.46)	0.26 (0.44)
Adjusted Charges Z-score	-0.66 (0.78)	-0.58 (0.66)	-0.58 (0.75)	-0.55 (0.52)	-0.21 (0.63)	-0.58 (0.73)
% Nonprofit	0.82 (0.38)	0.86 (0.35)	0.86 (0.35)	0.86 (0.35)	0.82 (0.38)	0.84 (0.36)
Patient & Physician Measures:						
Patient Distance # Miles	3.29 (2.23)	3.46 (2.34)	3.48 (2.33)	3.44 (2.29)	3.18 (2.17)	3.33 (2.19)
Physician Distance # Miles	3.18 (2.09)	3.52 (2.22)	3.36 (2.17)	3.36 (2.17)	2.75 (1.88)	3.05 (2.00)
Number of Available Physicians	30.06(14.49)	39.19(18.22)	37.09(17.01)	39.76(19.93)	18.64 (8.76)	41.95(19.78)
Prior Utilization by Physician	0.24 (1.51)	0.92 (4.67)	0.44 (2.52)	0.28 (1.92)	1.72 (8.71)	0.71 (3.63)

Table 4

Effects of Physician, Patient, and Hospital Characteristics on the Probability of Choosing a Hospital for Selected Medical & Surgical Diagnoses (standard errors in parentheses)

Model # 1

Independent Variables	Medical Conditions: Respiratory Infection	Acute Myocardial Infarction	Atrial Fibrillation	Gastro Intestinal Bleeding	Surgical Conditions: Aorta Repair/ Replacement	Large Bowel Resection
Patient Distance	-.312[c] (.010)	-.388[c] (.007)	-.354[c] (.007)	-.362[c] (.008)	-.276[c] (.009)	-.296[c] (.006)
Adjusted Mortality	.066 (.038)	-.301[c] (.023)	-.056[a] (.025)	-.074[c] (.022)	-.049 (.041)	-.061[a] (.026)
Out-of-state cases	.008 (.007)	.005[b] (.002)	.008[c] (.001)	.001 (.003)	.022[c] (.003)	-.001 (.003)
Medical School	.488[c] (.087)	.178[b] (.058)	.454[c] (.060)	.886[c] (.075)	.499[c] (.079)	.646[c] (.059)
Adjusted Charges	.217[c] (.049)	-.301[c] (.040)	.018 (.042)	.415[c] (.071)	.156[a] (.069)	-.009 (.038)
Nonprofit	-.224[a] (.104)	.212[b] (.073)	.149 (.088)	-.028 (.082)	-.009 (.100)	.476[c] (.083)
-2 Log Likelihood	1979	4985	4176	3448	2145	4287
Likelihood Ratio+	900/6[c]	3396/6[c]	2488/6[c]	2102/6[c]	804/6[c]	1920/6[c]
Pseudo R^2	.315	.403	.376	.380	.273	.310

a $p < .05$
b $p < .01$
c $p < .001$

\+ Compared to Equiprobable (Constant only) model

Table 5

Effects of Physician, Patient, and Hospital Characteristics on the Probability of Choosing a Hospital for Selected Medical & Surgical Conditions (standard errors in parentheses)

Model # 2

Medical Conditions

Independent Variables	Respiratory Infection # 2a	Respiratory Infection # 2b	Respiratory Infection # 2c	Acute Myocardial Infarction # 2a	Acute Myocardial Infarction # 2b	Acute Myocardial Infarction # 2c	Atrial Fibrillation # 2a	Atrial Fibrillation # 2b	Atrial Fibrillation # 2c
Patient Distance	-.308[c] (.019)	-.307[c] (.019)	-.309[c] (.020)	-.378[c] (.010)	-.379[c] (.010)	*	-.335[c] (.012)	-.334[c] (.012)	*
Adjusted Mortality	.101[a] (.044)	.149[b] (.047)	.009 (.053)	-.296[c] (.027)	-.237[c] (.032)	*	-.085[b] (.030)	-.063[a] (.030)	*
Out-of-state cases	-.010 (.010)	-.018 (.010)	-.022 (.012)	.012[c] (.002)	.010[c] (.002)	*	.010[c] (.002)	.003 (.002)	*
Medical School	.458[c] (.106)	.352[b] (.111)	.278[a] (.122)	.106 (.068)	.096 (.068)	*	.273[c] (.069)	.171[a] (.072)	*
Adjusted Charges	.211[c] (.053)	.200[c] (.051)	-.024 (.062)	-.298[c] (.044)	-.236[c] (.048)	*	.152[b] (.055)	.034 (.058)	*
Nonprofit	-.291[a] (.126)	-.551[c] (.135)	.034 (.155)	.132 (.080)	.036 (.085)	*	.336[c] (.100)	-.002 (.106)	*
Physician Distance	-.499[c] (.018)	-.499[c] (.018)	-.332[c] (.018)	-.400[c] (.009)	-.396[c] (.009)	*	-.469[c] (.011)	-.457[c] (.011)	*
Physician Supply	....	.021[c] (.004)	....	....	.006[b] (.002)	*	....	.014[c] (.002)	*
Prior Utilization by Physician	....	....	.774[c] (.050)	....	....	*	....	....	*
Likelihood Ratio[+] /d.f.	781/1[c]	14/1[c]	319/1[c]	1649/1[c]	5/1[a]		1535/1[c]	32/1[c]	

Medical Conditions (cont.) / Surgical Conditions

Independent Variables	Gastro Intestinal Bleeding # 2a	Gastro Intestinal Bleeding # 2b	Gastro Intestinal Bleeding # 2c	Aorta Repair/ Replacement # 2a	Aorta Repair/ Replacement # 2b	Aorta Repair/ Replacement # 2c	Large Bowel Resection # 2a	Large Bowel Resection # 2b	Large Bowel Resection # 2c
Patient Distance	-.321[c] (.014)	-.320[c] (.014)	-.309[c] (.014)	-.305[c] (.015)	-.304[c] (.015)	-.280[c] (.015)	-.259[c] (.011)	-.253[c] (.011)	-.304[c] (.012)
Adjusted Mortality	-.045[a] (.023)	.050 (.026)	-.087[b] (.027)	-.155[b] (.044)	-.090[a] (.046)	-.056 (.055)	-.082[b] (.028)	-.043 (.028)	-.059 (.031)
Out-of-state cases	-.003 (.004)	-.001 (.004)	.001 (.005)	.016[c] (.004)	.002 (.005)	.012 (.005)	.031[c] (.004)	.036[c] (.004)	.007 (.005)
Medical School	.507[c] (.087)	.247[b] (.094)	.222[a] (.099)	.117 (.086)	-.184 (.113)	-.124 (.101)	.357[c] (.069)	.058 (.080)	.211[b] (.081)
Adjusted Charges	.556[c] (.084)	.326[c] (.090)	.150 (.094)	.407[c] (.093)	.608[c] (.107)	.363[b] (.107)	-.090[a] (.045)	-.010 (.046)	-.164[b] (.052)
Nonprofit	.055 (.096)	-.323[b] (.109)	.072 (.117)	.273[a] (.112)	-.257 (.170)	.489[b] (.152)	.548[c] (.092)	.263[b] (.100)	.557[c] (.108)
Physician Distance	-.483[c] (.014)	-.475[c] (.014)	-.332[c] (.014)	-.427[c] (.017)	-.425[c] (.017)	-.258[c] (.016)	-.461[c] (.012)	-.454[c] (.012)	-.325[c] (.012)
Physician Supply	....	.013[c] (.002)	....	....	.031[c] (.007)	....	....	.013[c] (.001)	....
Prior Utilization by Physician	....	....	.557[c] (.024)	....	....	.164[c] (.010)	....	....	.250[c] (.011)
Likelihood Ratio[+] /d.f.	1233/1[c]	33/1[c]	521/1[c]	627/1[c]	9/1[b]	400/1[c]	1529/1[c]	42/1[c]	614/1[c]

a p < .05   b p < .01   c p < .001

* Model did not converge. Parameters could not be estimated.

\+ Model #2a compared to Model #1. Models #2b and #2c compared to #2a.