The Effect of Chain Membership on Hospital Costs

Terri J. Menke

Objective. To compare the cost structures of hospitals in multihospital systems and independently owned hospitals.
Data Sources. The American Hospital Association's Annual Survey from 1990 for data on hospital costs and attributes. Area characteristics came from the Area Resource File, and the Medicare case-mix index came from the Health Care Financing Administration. Data on wages are from the Bureau of the Census' *State and Metropolitan Area Data Book*. The *Guide to Hospital Performance* from HCIA, Inc. provided data on quality of care.
Study Design. Separate cost functions were estimated for chain and independent hospitals. Hybrid translog cost functions included measures of outputs, input prices, and hospital and area characteristics. The estimation method accounted for the simultaneous determination of costs and chain membership, and for any nonrandom selection of hospitals into chains. Several economic cost measures were calculated to compare the cost structures of the two types of hospitals.
Data Extraction Methods. Data from all sources were merged at the hospital level to form the study sample.
Principal Findings. Hospitals in multihospital systems were less costly than independently owned hospitals. Among independent hospitals, for-profits had the highest costs. There were no statistically significant differences in costs by ownership among chain members. Economies of scale were enjoyed in both types of hospitals only at high volumes of output, while economies of scope occurred at all volumes for chain hospitals, but only at low and medium volumes for independent hospitals.
Conclusions. This study provides support for the idea that growth of the multihospital system sector can provide a market solution to the problem of constraining costs. It does not, however, support the property rights theory that proprietary hospitals are more efficient than nonprofit hospitals.

Key Words. Hospital costs, chain hospitals, multihospital systems, hospital ownership

THE EFFECT OF CHAIN MEMBERSHIP ON HOSPITAL COSTS

The increasing consolidation of the hospital industry makes it important to know the impact of multihospital systems on costs. Chain hospitals comprised 34.4 percent of nonfederal hospitals in 1990, up from the 1985 figure of 27.6 percent (American Hospital Association 1985, 1990). Conventional wisdom suggests that chain hospitals realize cost savings over independently owned hospitals and, therefore, that the growth of the multihospital system sector provides a market solution to the problem of constraining costs. Multihospital systems are thought to benefit from centralized management and planning, volume discounts on purchasing, and other economies due to their size.

The concentration of for-profit hospitals in chains provides additional impetus to the hypothesis that multihospital system members are more efficient, on average, than independent hospitals. Three-quarters of for-profit hospitals were part of chains in 1990, compared to 41 percent of nonprofit hospitals and 8 percent of public hospitals. Property rights theory states that the lack of an incentive for nonprofit hospitals to maximize profits leads to a divergence from efficient behavior.

Contrary to these theoretical expectations, previous research found that chain hospitals were more costly than independent hospitals. This study provides new evidence on the relative efficiency of chain and independent hospitals. The study improves on past studies in several ways. First, the data used here are recent. Most of the available literature used data from the era of cost-based reimbursement, when the incentives for cost minimization were weaker. Second, unlike earlier research, this study tests whether or not chain and independent hospitals have different cost structures. Third, the estimation method allows for the possibility that chains tend to acquire inefficient facilities, so that costs and chain membership are simultaneously determined, and it controls for any nonrandom selection process of hospitals into chains. Finally, this study tests the property rights theory separately for chain and independent hospitals.

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Address all correspondence and requests for reprints to Terri J. Menke, Ph.D., Research Health Economist, HSR&D Field Program, VAMC (152) 2002 Holcombe, Houston, TX 77030. This article, submitted to *Health Services Research* on August 3, 1995, was revised and accepted for publication on July 26, 1996.

CONCEPTUAL FRAMEWORK

Chain hospitals are attributed with the benefits of economies of scale: a decrease in long-run average cost as output increases. It is firm-level scale economies that are relevant. Multihospital systems gain an economic advantage if cost savings due to chain ownership are conferred to member hospitals. These savings take the form of lower average costs at any given level of output for each member hospital. Both independent and chain hospitals benefit from economies of scale at the individual hospital level, which refers to a decrease in average costs as output at a given hospital increases.

Economies of scale at the firm level can be due to joint purchasing that yields volume discounts, such as lower prices for medical supplies or drugs. Chains might obtain lower interest rates on capital. Input sharing arrangements, such as a common medical claims processing system, might lower costs. Chains might have a more highly skilled management staff, or they might offer better nonpecuniary benefits, such as career advancement, which could lead to a more productive work force for a given wage.

Multihospital system members might also be more efficient than independent hospitals, on average, because of the concentration of for-profit hospitals in chains. The property rights theory assumes that for-profit hospitals maximize profits, because the owners hold a residual claim to the hospital's net revenues. Nonprofit hospitals might not achieve economic efficiency, since neither owners nor managers can gain financially from the efficient operation of a nonprofit hospital. Nonprofit hospitals have been modeled in a variety of ways (Register, Sharp, and Bivin 1985). One model assumes that the nonprofit hospital is in the control of the physicians on its medical staff, who operate the hospital to maximize their joint profit. Another model assumes that the nonprofit hospital's manager seeks to maximize the quality of the hospital, subject to a revenue constraint, by enhancing the range and complexity of its services. Quantity maximization subject to a revenue constraint is the assumed objective of nonprofit hospitals in a third model. Whatever the objective, nonprofit hospitals are assumed to minimize costs for given levels of outputs, input prices, and other exogenous factors. For-profit hospitals necessarily attempt to minimize costs as a consequence of their efforts to maximize profits.

If the property rights theory holds, system members are expected to be more efficient than independent hospitals, on average, because of the high proportion of for-profit hospitals in chains. Furthermore, for-profit chain hospitals should have lower costs than nonprofit chain hospitals, and for-profit independent hospitals should have lower costs than nonprofit independent hospitals.

PREVIOUS RESEARCH

The preponderance of past studies does not support the hypothesis that chain hospitals are more efficient than independent hospitals. Several descriptive analyses found that costs per day or per admission were higher in investor-owned system members than in nonprofit hospitals (Pattison and Katz 1983; Cleverly 1992). Some regression analyses confirmed these results. Becker and Sloan (1985) found that proprietary chain hospitals had the highest costs per day and per admission. Coelen (1986) found that proprietary chain hospitals were the most expensive, followed by nonprofit chain members, nonprofit independent hospitals, and for-profit independent hospitals. Coyne (1982) showed that system members were more costly than independent hospitals, stratified by various categories of proprietary or nonprofit status. Some studies found no difference in costs between system and independent hospitals (Lewin, Derzon, and Margulies 1981; Watt, Derzon, Renn, et al. 1986; Renn et al. 1985; Custer and Wilke 1991; Vita 1990). A few even found lower costs in chain hospitals (Sloan and Vraciu 1983; Brown, Warner, Luehrs, et al. 1980).

One explanation for the findings of higher costs in chain hospitals is that most of the studies used data from years prior to implementation of the cost-containment measures that are the norm today. Several of the forementioned studies found that even though system hospitals were more costly than independent hospitals, they were also more profitable, because they were able to use aggressive marketing and pricing strategies to maximize reimbursements. The authors noted that the era of cost containment would be expected to force multihospital systems to focus on controlling costs. Consequently, even though the previous literature suggests that system hospitals are at least as costly as independent hospitals, this finding might be overturned with the more recent data used here.

Another explanation for the higher costs in system hospitals is that chains tend to acquire inefficient facilities, and that it takes time to achieve cost savings (Becker and Sloan 1985; Brown 1982). An observation of higher costs in chain hospitals might reflect inefficiencies left over from the operation of the hospitals prior to their purchase by chains. This study uses a simultaneous equations model to eliminate this feedback effect of high costs on chain acquisition.

There is also a great deal of literature testing the property rights theory, resulting in mixed evidence. Some of the studies found for-profit hospitals to be more costly than nonprofit hospitals (Register, Sharp, and Stevans 1988; Grannemann, Brown, and Pauly 1986; Custer and Wilke 1991), while others found the opposite result (Cowing and Holtmann 1983; Robinson and Luft 1985). Some found no difference in costs between proprietary and nonprofit hospitals (Vita 1990). As with the studies on multihospital systems, tests of the property rights theory are generally based on data from the 1970s or early 1980s. Cost-containment strategies by payers are expected to diminish the cost differential between for-profit and nonprofit hospitals.

ESTIMATION METHOD

The cost structures of chain and independently owned hospitals are compared based on the estimates from separate hybrid translog cost functions (Grannemann, Brown, and Pauly 1986). The F-statistic to test the null hypothesis that the slope coefficients are equal for the two types of hospitals supports the estimation of separate cost equations. The hybrid translog cost function has several advantages over the strict translog form. The hybrid translog allows zero output levels and the inclusion of a variety of factors that shift the cost function. It maintains a polynomial structure of outputs like the one used in the translog form. It is also the most comparable to previous work on hospital costs.

The following specification was used:

$$\ln(C) = \alpha + \sum \beta_i Y_i + .5 \sum \sum \gamma_{ij} Y_i Y_j + \sum \delta_i Y_i^3 + \phi \ln(P) + \sum \eta_i P Y_i + \sum \theta_k Z_k + \varepsilon$$

where C is total costs, Y is a vector of outputs, P represents input price, Z is a vector of other factors that shift the cost function, and ε is a residual error term.

The procedure used to estimate the cost functions accounts for the simultaneous determination of costs and chain membership, and includes adjustment terms for any selection bias. The model is among those with limited dependent and qualitative variables, and is described by Maddala (1983, 223–28). Hospitals are assumed to choose the status, chain or independent, that maximizes their objective function. Observed costs depend on the hospital's status. That is, we observe chain hospitals' costs only when they are chains, and vice versa for independent hospitals. We do not know how a given hospital's costs would be different if it had the alternative status. Therefore, hospital costs are limited dependent variables, and ordinary least squares (OLS) estimation of the cost equations yields biased coefficient estimates.

To obtain unbiased coefficients, a two-stage estimation procedure is used. In the first stage, a probit model estimates the probability of chain membership. Costs are included among the explanatory variables to allow for the simultaneous determination of costs and chain membership. However, instead of actually including costs, the estimation proceeds by substituting the explanatory variables from the cost equation into the probit model. The probit estimates are used to derive selectivity variables that are added to the cost equations. For chain hospitals, the selectivity term equals $f(\text{sum})/F(\text{sum})$, where f and F are the density and distribution functions of the standard normal variable. For independent hospitals, the selectivity term is $f(\text{sum})/[1 - F(\text{sum})]$. To calculate the "sum" term for a given hospital, the value of each explanatory variable is multiplied by the corresponding probit coefficient estimate, and the results are summed. When the selectivity variables are included in the cost equations, OLS yields consistent coefficient estimates. However, the residuals of the model with selectivity are heteroscedastic. Therefore, the cost equations are estimated using weighted least squares.

EMPIRICAL SPECIFICATION

The dependent variable of the cost equation is the log of total costs, including the cost of capital. Therefore, the equation represents a long-run cost function. The use of a long-run equation follows others who argue that capital is not exogenous because hospitals do change their capital stock over time. Therefore, including capital as an explanatory variable in a short-run cost equation would result in simultaneous equations bias (Grannemann, Brown, and Pauly 1986). In addition, chain hospitals might have better access to capital markets, so capital costs should be included in the dependent variable.

The outputs are the number of discharges, the number of inpatient days, and the number of outpatient visits. The inclusion of both discharges and days follows the recommendation of Breyer (1987) and has been used by others (Grannemann, Brown, and Pauly 1986; Custer and Wilke 1991; Hadley and Swartz 1989). Including both discharges and inpatient days accounts for differences in length of stay across hospitals. Two hospitals could have the same total number of inpatient days but differ in their average lengths of stay and in their costs.

The specification assumes that capital is traded in national markets, and therefore, the price of capital is excluded. The area average retail salary measures the price of the labor input. Areas were defined as metropolitan statistical areas (MSAs) and all nonmetropolitan areas combined within a state. This measure of labor costs is exogenous to the hospital, although it is not known if it accurately reflects the costs of the types of occupations employed in hospitals. The average annual salary of employees for each hospital is used in an alternative specification, with little effect on the results.

Control variables typically found in hospital cost studies are also included. The Medicare case-mix index is the main case-mix measure. Although it is calculated using only Medicare discharges, past studies have found that the Medicare case-mix index accurately reflects overall case-mix differences (Thorpe 1988; Pettengill and Vertrees 1982). Additional case-mix variables control for the distribution of the hospital's cases among acute, intensive, and subacute care, and between emergency department and other outpatient visits. Quality of care is reflected by variables denoting whether the hospital has a mortality rate that is above, below, or within the range expected based on the clinical risk of the hospital's patients. Hospital characteristics include the Medicare and Medicaid shares of discharges and inpatient days, affiliation with a medical school, membership in the Council of Teaching Hospitals (COTH), the number of available services, and proprietary, nonprofit, or public ownership. Four area characteristics are defined for MSAs and rural counties. The physician-to-population ratio is generally associated with higher hospital costs (Hadley and Swartz 1989; Robinson and Luft 1985). More physicians could lead to more services provided, or to hospitals expanding their technological capabilities to attract physicians. A Herfindahl index measures hospital competition. Past studies found that costs are higher in areas of greater competition, because competition includes increasing the amenities or quality of care provided (Thorpe 1988; Vitaliano 1987). Geographic dummy variables denoting region and urban versus rural location reflect unmeasured differences in practice patterns, quality of care, and case mix.

As discussed earlier, the cost equations were estimated by a two-stage method. The first stage consists of a probit equation to estimate the probability of chain membership. The explanatory variables are based on the work of Alexander and Morrisey (1988). They hypothesized that chain acquisition is more likely in favorable markets, for hospitals with less competent management, and when the missions of the hospital and chain coincide. Favorable market conditions are reflected by a larger (smaller) proportion of Medicare (Medicaid) discharges, more physicians per capita, fewer beds per capita, fewer hospitals, a larger population, higher average income, a lower unemployment rate, a larger percentage of elderly, and a smaller proportion of physicians aged 45 to 54. Better management is measured by a higher occupancy rate, which reflects the ability to market the hospital's services. The hospital's mission is measured by ownership, bed size, medical school affiliation, and the number of available services. In addition, all explanatory variables in the cost equation are included to allow for the simultaneous determination of costs and chain membership.

The cost equations allow the calculation of several cost measures that form the basis for comparing the cost structures of chain and independent hospitals. The marginal cost of an output is the extra cost of producing the last unit of output, calculated as the first derivative of the cost function with respect to that output. The cost function used includes both inpatient days and discharges as outputs. The marginal cost of a discharge measures the cost of ancillary services, such as tests and surgeries, while the marginal cost of an inpatient day measures the cost of the routine, daily services that depend on the patient's length of stay. Evaluating the marginal cost of days or discharges while holding the other constant would imply an enormous change in length of stay. Therefore, to calculate the marginal cost of a discharge, inpatient days are varied to keep length of stay constant at its mean level. Similarly, discharges are varied to keep length of stay constant at its mean when the marginal cost of an inpatient day is calculated (Grannemann, Brown, and Pauly 1986). The marginal cost of an inpatient stay then equals the marginal cost of a discharge plus the product of the marginal cost per day and length of stay. The average incremental cost is the multiproduct analog of average cost. For output Y_1, for example, it is: $AIC(Y_1) = [C(Y_1, Y_2, Y_3) - C(0, Y_2, Y_3)]/Y_1$ (Baumol, Panzer, and Willig 1982). The separate average incremental costs for days and discharges are not well defined, so the average incremental cost per stay is computed. Inpatient days are varied with discharges to keep length of stay at its mean value.

Economies of scale are present in the production of an output if costs rise more slowly than output. For a multiproduct cost function, product-specific economies of scale for output Y_1 are defined as: $EOS_1 = AIC_1/MC_1$. Returns to scale are increasing if EOS is greater than one, decreasing if EOS is less than one, and constant if EOS equals one. Since average incremental cost is not defined separately for discharges and inpatient days, economies of scale is calculated for stays. Economies of scope are present if it is cheaper to produce outputs jointly than to produce them separately. If C represents total costs, Y_1 denotes discharges, Y_2 days, and Y_3 visits, then economies of scope between outpatient visits and inpatient stays is: $EOSC = [C(0, 0, Y_3) + C(Y_1, Y_2, 0) - C(Y_1, Y_2, Y_3)]/C(Y_1, Y_2, Y_3)$. Economies (diseconomies) of scope are present if $EOSC$ is greater than (less than) zero.

The cost measures are evaluated at the combined means for chain and independent hospitals for all variables other than the outputs. The outputs are set at specified levels to indicate how costs differ for low-, medium-, and high-volume hospitals. The selectivity variables are not included in the cost calculations. Parametric retransformation is used to calculate dollar units from logarithmic units, since the Shapiro-Wilk test showed that the regression residuals are lognormally distributed.

DATA

The data come from the American Hospital Association's 1990 Annual Survey. The response rate to this annual survey of all U.S. hospitals is about 95 percent but tends to be higher for larger hospitals, those in the East or the North, and nonprofit hospitals. Only nonfederal, general medical/surgical hospitals are included in this study. Chain hospitals are defined as those reporting membership in a multihospital system. The Health Care Financing Administration provides the Medicare case-mix index. Retail salaries are from the Bureau of the Census' *State and Metropolitan Area Data Book*. The *Guide to Hospital Performance* from HCIA, Inc. provides the quality of care data. The Area Resource File (ARF) provides information on area characteristics. For MSAs, county level ARF data are combined.

The complete set of variables is available for 2,200 hospitals. Of these, 58.2 percent (1,281) are independently owned and 41.8 percent (919) are members of hospital systems. Table 1 provides means and standard deviations for the cost regression variables. On average, chain hospitals have total expenses of $67.5 million, compared to $49.1 million for independent hospitals. The numbers of discharges, inpatient days, and outpatient visits are all significantly higher for system hospitals. The case-mix index is also higher for chain hospitals, 1.33 versus 1.24 for independent hospitals. No statistically significant differences between chain and independent hospitals are found in the distributions of discharges by type or among payer groups, of visits between emergency and other, or of days by payer.

For-profit hospitals are more heavily represented in systems. Nearly 20 percent of chain hospitals are investor-owned, while just 3.4 percent of independent hospitals are proprietary. Three-fourths of system hospitals are

Table 1: Descriptive Statistics

	Chain Hospitals		Independent Hospitals	
Variable	*Mean*	*s.d.*	*Mean*	*s.d.*
Expenses ($1000s)*	$67,538.65	$66,483.54	$49,127.27	$60,323.90
Ln(expenses)*	17.61	0.95	17.20	1.01
Discharges*	9,997.27	7,844.99	7,756.24	6,615.86
Days*	70,040.52	60,250.40	54,504.48	52,364.51
Visits*	88,641.16	116,599.87	76,585.22	81,691.41
Ln(wage)*	9.33	0.18	9.26	0.19
Case-mix index*	1.33	0.19	1.24	0.18
Discharge type				
% Acute	0.732	0.16	0.756	0.18
% Intensive care	0.111	0.07	0.093	0.06
% Subacute	0.157	0.17	0.151	0.19
Visit type				
% Emergency	0.370	0.17	0.361	0.17
% Other	0.630	0.17	0.639	0.17
Discharges by payer				
% Medicare	0.382	0.11	0.384	0.11
% Medicaid	0.121	0.11	0.146	0.10
% Other	0.497	0.12	0.470	0.11
Days by payer				
% Medicare	0.482	0.13	0.481	0.14
% Medicaid	0.116	0.11	0.144	0.12
% Other days	0.402	0.12	0.375	0.11
Ownership*				
% For-profit	0.194	0.40	0.034	0.18
% Nonprofit	0.756	0.43	0.669	0.47
% Public	0.050	0.22	0.297	0.46
Urban*	0.785	0.41	0.585	0.49
Teaching hospital*	0.317	0.47	0.217	0.41
Council of Teaching Hospitals	0.086	0.28	0.090	0.29
Herfindahl index*	0.284	0.31	0.427	0.37
MDs/capita*	0.002	0.00	0.010	0.00
Number of services*	30.900	11.76	27.200	11.90
Quality*				
% High	0.187	0.39	0.130	0.34
% Average	0.633	0.48	0.680	0.47
% Low	0.180	0.38	0.190	0.39
Region*				
% North Central	0.320	0.47	0.311	0.46
% Northeast	0.103	0.30	0.176	0.38
% West	0.174	0.38	0.108	0.31
% South	0.403	0.49	0.405	0.49

Note: Tests of the differences between system and independent hospitals were conducted using *t*-tests for continuous variables and Chi-square tests for categorical variables.

* Difference between system and independent hospitals is statistically significant at the .01 level.

private and nonprofit, while two-thirds of independent hospitals fall into this category. About 30 percent of independent hospitals are publicly owned, compared with 5 percent of chain members.

The concentration of chain hospitals in urban areas is reflected in the higher proportion affiliated with medical schools, a lower average Herfindahl index, and a higher number of physicians per capita. Chain hospitals offer 31 services, on average, compared with 27 services offered by independent hospitals. The proportion of hospitals with better than average quality is higher among system members, 18.7 percent, compared with 13 percent among independent hospitals. About one-third of both system and independent hospitals are located in the North Central region, and about 40 percent in the South. However, a higher proportion of chain members is found in the West and a lower proportion in the Northeast.

EMPIRICAL RESULTS

The cost equation estimates for chain and independent hospitals allowing for the simultaneous determination of costs and chain membership, and for any nonrandom selection of hospitals into chains, are given in the Appendix. The estimates of the probit equation for chain membership used in the first stage of the estimation procedure, and OLS estimates of a pooled equation that includes a dummy variable for chain membership, are also given. The pooled equation assumes that membership in a multihospital system affects only the intercept of the cost function. Pooling and using OLS regression is the usual approach in the literature. In this regression, the chain membership dummy variable is positive and statistically significant, indicating that chain hospitals have higher costs than independent hospitals. However, the F-statistic to test the equality of the regression coefficients between the two types of hospitals was 19.6, leading to a rejection of the pooled regression approach. Therefore, the remainder of this discussion focuses on the separate estimates.

The output variables do not always exhibit the usual positive-negative-positive pattern for the linear, squared, and cubic terms, respectively. However, the shapes of the average incremental cost curves depend not only on the signs of the output coefficients but also on their relative magnitudes and on the coefficients of the interaction terms.

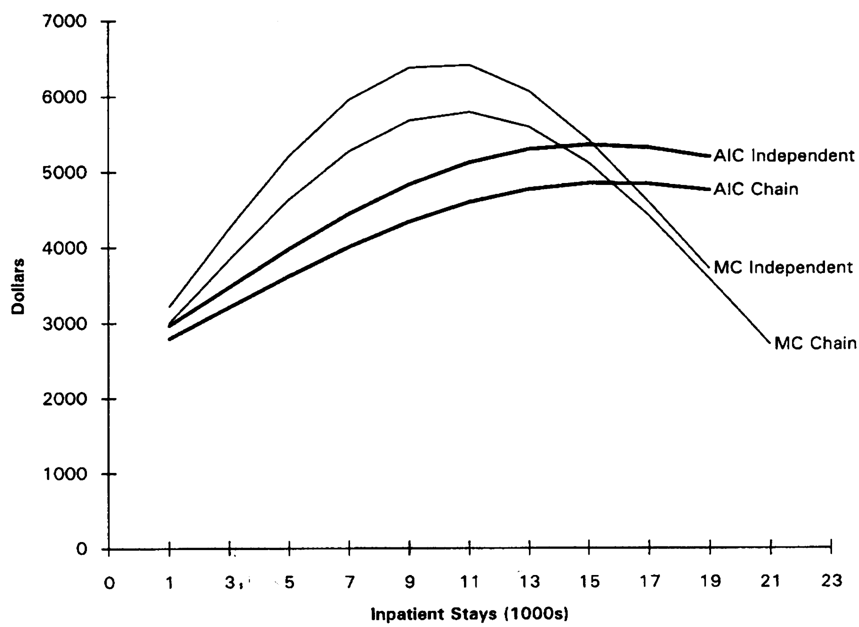
The property rights theory does not hold in these data. Among independent hospitals, proprietary hospitals have the highest costs, followed by nonprofit hospitals and public hospitals. Relative to public hospitals, for-profit independent hospitals have costs that are 28 percent higher, and nonprofit independent hospitals have costs that are 10.7 percent higher, using Kennedy's correction for dummy variables in a semilogarithmic equation (Kennedy 1981). No statistically significant differences in costs occur among the ownership categories for chain hospitals.

Higher costs occur in hospitals with higher case-mix indexes, and in those with higher shares of intensive care discharges relative to subacute discharges. A lower share of acute discharges also leads to higher costs among independent hospitals. Apparently, longer stays lead to higher costs for subacute discharges relative to acute discharges but not relative to intensive care discharges. Emergency visits are more intensive than other outpatient visits, leading to higher costs, although the coefficient is not statistically significant among chains. The percentages of discharges and days represented by Medicare and Medicaid patients generally have negative signs when they are statistically significant, indicating that larger shares of Medicare or Medicaid patients lead to lower costs. These variables are likely to reflect unmeasured case-mix differences or intensity of care provided to patients covered by different payers. Hospitals affiliated with a medical school do not exhibit different costs from unaffiliated hospitals, but COTH membership does have a positive effect on costs for chain hospitals. The number of available services is positively correlated with costs for both groups of hospitals. The only statistically significant quality measure is the proportion of chain hospitals with higher than average quality, which has an expected positive effect on costs. Unexpectedly, independent hospitals in urban areas have lower costs, and the difference in costs between urban and rural areas is not statistically significant for chains. This result might be due to the inclusion of many control variables in the regressions that explain the observed higher costs of urban hospitals. The Herfindahl index has the usual negative coefficient, and the number of physicians per capita has a positive impact on independent hospital costs. Both chain and independent hospitals in the North Central and Western states have the highest costs. The selectivity variable is statistically significant only for independent hospitals, indicating that OLS estimates would be unbiased for chain hospitals but not for independent hospitals.

The cost function results were used to calculate marginal costs, average incremental costs, product-specific economies of scale, and economies of scope for inpatient and outpatient care. Figure 1 is a graph of average incremental costs and marginal costs for inpatient stays. Chain members have lower average incremental and marginal costs per stay than independent hospitals for all volumes. The gap in average incremental costs widens as the number of stays increases. At 3,000 stays, the difference is $265 ($3,478 for independent hospitals and $3,213 for chain hospitals). At 13,000 stays, the difference is $531 ($5,307 for independent hospitals and $4,776 for chain hospitals).

Even though the marginal cost per stay is lower for system hospitals, the marginal cost per inpatient day is higher for chain hospitals except at very high levels of days. The contribution of lower marginal costs per discharge to the marginal cost per stay among chains outweighs the higher marginal cost per day. The difference in the marginal cost per day between chain and independent hospitals is between about $200 and $250 until 60,000 days are produced (e.g., $450 for chains and $201 for independent hospitals at 60,000 days), and then the gap narrows. At about 130,000 days, the marginal cost per day becomes lower for system members. This result implies that the cost of routine, daily services is higher for system members until a very high volume is reached. In contrast, the marginal cost per discharge is lower for system members than for independent hospitals, although the gap narrows as the volume rises. This result implies that the cost of ancillary services is lower for chain hospitals.

Figure 1: Marginal and Average Incremental Cost per Stay

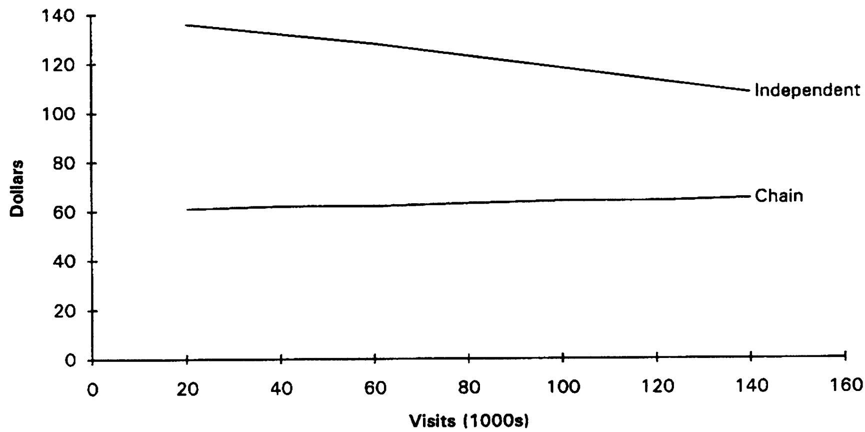


The magnitudes of the inpatient cost measures found here are similar to those in past studies after the other studies' results are inflated to 1990 dollars using the medical component of the consumer price index. Here, the marginal costs per discharge at the mean levels of discharges are $4,860 for independent hospitals and $2,546 for chain hospitals. The marginal cost per discharge at the mean was $3,502 in Custer and Wilke's article (1991), and $3,306 for medical/surgical discharges in the study by Vita (1990). However, Grannemann, Brown, and Pauly (1986) found a lower marginal cost per acute care discharge, $1,728. Here, the marginal costs per day at the mean numbers of days are $186 for independent hospitals and $462 for chain hospitals. This latter figure is nearly identical to Grannemann, Brown, and Pauly's marginal cost per day of $465, and the range found here spans Custer and Wilke's figure of $267. Here, the marginal costs per stay at the mean numbers of stays are $6,168 for independent hospitals and $5,783 for chain members, compared to Grannemann, Brown, and Pauly's figure of $4,984. There are hospital level diseconomies of scale for both system and independent hospitals at low and medium levels of stays. The average incremental cost per stay does become flat at high volumes, and economies of scale actually occur at very high volumes. These results conform with some previous studies (Grannemann, Brown, and Pauly 1986; Custer and Wilke 1991).

The average incremental cost per outpatient visit is lower for chain than for independent hospitals (Figure 2). The average incremental cost for chain hospitals hovers between $60 and $65, indicating nearly constant returns to scale in the production of visits. Economies of scale in the production of visits are seen for independent hospitals: average incremental costs fall from about $140 at 10,000 visits to under $110 at 140,000 visits. Past studies have found nearly constant returns to scale in the production of outpatient visits (Grannemann, Brown, and Pauly 1986; Custer and Wilke 1991). The values for the marginal cost per visit found here fall within the wide range of values in past studies, from $47 to $163 in 1990 dollars (Grannemann, Brown, and Pauly 1986; Custer and Wilke 1991; Vita 1990).

Economies of scope between inpatient and outpatient care occur at all volumes for chain hospitals and at volumes up to the means for independent hospitals. At the mean levels of stays and visits, joint production reduces costs by about 3 percent for independent hospitals and about 11 percent for chain hospitals. Previous researchers have not found support for the existence of economies of scope among various combinations of outputs at their mean levels (Grannemann, Brown, and Pauly 1986; Vita 1990; Cowing and Holtmann 1983), although there are exceptions (Custer and Wilke 1991).

Figure 2: Average Incremental Cost per Visit



CONCLUSIONS

This study demonstrates that chain and independent hospitals have different cost structures that require estimating separate cost functions. In addition, the estimation method allows for the simultaneous determination of costs and chain membership and for any nonrandom selection of hospitals into chains. The typical approach of constraining the slope coefficients to be equal for system members and independent hospitals, and estimating the difference in their costs by a dummy variable, yields the incorrect conclusion that costs are higher for chain hospitals.

The results of this study's separate estimations have several important implications. First, they support the hypothesis that chain hospitals are more efficient than independent hospitals. Multihospital systems are hypothesized to have an economic advantage from joint purchasing of inputs, sharing inputs, lower capital costs, and better nonpecuniary benefits for employees. The marginal and average incremental costs of both outpatient and inpatient care are lower for chain members at all volumes. The average incremental cost per outpatient visit ranges between \$60 and \$65 for chain hospitals, but is between \$100 and \$140 for independent hospitals. The difference in the average incremental cost per inpatient stay widens in absolute dollars as the volume of care rises, although the percentage difference does not change much. At 3,000 stays, the average incremental cost per stay is $265 or 8 percent lower for chains, while at 13,000 stays, the gap is $531 or 11 percent.

The lower costs of chain hospitals are evidence that the growth of the multihospital system sector can provide a market mechanism to control costs. The findings of previous studies that chain members have higher costs are overturned here. One reason for the different result here is that the past studies used data from the era of cost-based reimbursement. Chain hospitals employed techniques to maximize their reimbursements, and it was hypothesized that the (then) new cost-containment measures being implemented would shift the focus from reimbursement maximization to cost minimization. Second, chains tend to purchase financially troubled facilities, which confounds the relationship between costs and chain membership. A simultaneous equations model is used here to disentangle this relationship.

A second major result of this study is the lack of support for the property rights theory. Property rights theory holds that nonprofit hospitals are less efficient than proprietary hospitals. Since neither owners nor managers hold a residual claim to net revenues, nonprofit hospitals have objectives other than the maximization of profits. However, this study finds that among independent hospitals, proprietary hospitals are 28 percent more costly and nonprofit hospitals 10.7 percent more costly than public hospitals. There is no difference in costs among the ownership categories for system members. Public hospitals' costs might be understated, however, because the data measure accounting costs, not economic costs. If public hospitals tend to be older than private hospitals, they might be fully depreciated and report zero capital costs. In the data used here, the percentage of costs represented by depreciation and interest was lowest among public hospitals. Unfortunately, facility age is not included in the data and therefore could not be taken into account in the analyses. However, the relative costs among ownership categories changed only slightly when the cost functions were estimated using only operating costs as the dependent variable. Operating costs might represent more accurately the relative costs among ownership categories.

Third, this article provides additional evidence for the existence of economies of scope and scale at the hospital level. The results show that the size of the hospital must be balanced against the degree of specialization to achieve efficiency. Economies of scope between inpatient and outpatient care occur at all volumes for chain hospitals but only at low and medium volumes for independent hospitals. There are nearly constant returns to scale in outpatient care for system members, and increasing returns to scale for independent hospitals. For both chain and independent hospitals, economies of scale occur in the provision of inpatient care only at very high volumes. While this result might appear to be counterintuitive since it is smaller hospitals that have been closing, it may be that larger hospitals also have higher revenues and profits than smaller facilities. Alternatively, available measures might not adequately account for higher quality or sicker patients in larger hospitals. Studies using survivor analysis, which relates hospital size to changes in market share or output, have found economies of scale in the hospital industry (Frech and Mobley 1995). Survivor analysis captures economies due to all types of factors. These factors include those that statistical analyses of cost or production might not be able to take adequately into account, such as quality and case mix. These factors also include those that are unrelated to efficiency, such as the ability to deal with regulators, unless variables are included in the analysis to control for such factors. (Frech and Mobley do include such variables in their model.) Further research will be needed to resolve the discrepancy between the results of cost and production studies and survivor analysis.

With the death of federally directed healthcare reform, market mechanisms to control healthcare costs will continue to be of paramount importance. This study supports the view that the growth of multihospital systems constrains costs. It does not, however, support the view that proprietary hospitals are more efficient than nonprofit or public hospitals.

Appendix: Regression Results

	Log of Total Hospital Costs			
Independent Variable	*Chain*	*Independent*	*All*	*Probability of Chain Membership*
Intercept	10.43**	7.71**	7.22**	7.82
Discharges	4.74E-4**†	7.53E-4**	8.27E-4**	5.1E-4
Discharges^2	−4.36E-9**	−8.54E-9**	−4.17E-9**	−6.3E-9
Discharges^3	2.26E-14**	1.05E-13**	3.18E-14**	6.1E-14
Days	−3.49E-5	−3.12E-5	−4.17E-5**	−6.2E-5
Days^2	−1.20E-10**	−1.77E-11	−7.94E-11**	4.3E-11
Days^3	1.45E-16**	1.39E-17	1.19E-16**	−1.9E-16*
Visits	9.61E-6	6.07E-6**	5.15E-6	−8.5E-5**
Visits^2	−9.15E-14	−1.10E-11**	−3.79E-13	−1.1E-12
Visits^3	−2.80E-21	1.14E-17	5.04E-20	6.3E-19
Discharges X Days	4.82E-10**	9.46E-11	1.40E-10*	6.8E-10
Discharges X Visits	−6.29E-11*	−4.88E-11	−1.97E-11	−2.9E-10*
Days X Visits	4.35E-12	2.83E-12	7.57E-13	2.7E-11
Ln(wage)	0.52**	0.74**	0.83**	−1.0
Wage X Discharges	−4.06E-5*	−5.78E-5**	−7.51E-5**	−4.2E-5
Wage X Days	5.65E-6*	3.88E-6*	6.00E-6**	5.7E-6

Continued

Appendix: Continued

Independent Variable	*Log of Total Hospital Costs* Chain	Independent	All	*Probability of Chain Membership*
Wage X Visits	−8.72E-7	−2.26E-7	−4.05E-7	9.3E-6**
Case mix	0.53**	0.94**	0.71**	0.24
% Acute discharges	0.04	−0.15*	−0.02	−0.63*
% Intensive care discharges	0.30*	0.40**	0.37**	0.57
% Emergency visits	0.09	0.10*	0.05	0.57*
% Medicare discharges	−0.37*	−0.25*	−0.43**	1.49*
% Medicaid discharges	0.15	−0.19*	−6.29E-3	0.04
% Medicare days	0.26*	0.06	0.20**	−0.45
% Medicaid days	−0.31*	0.01	−0.17*	0.03
For-profit	−0.01	0.25**	0.09**	2.26**
Nonprofit	−0.04	0.10**	0.04**	1.13**
Teaching hospital	−0.02	−3.79E-3	−0.03	0.19*
Council of Teaching Hospitals member	0.16**	0.03	0.11**	−0.67**
Services	7.15E-3**	6.60E-3**	7.51E-3**	2.3E-4
High quality	0.05*	−9.07E-3	0.01	0.11
Low quality	−0.01	−6.72E-3	−0.01	−7.0E-3
Urban	0.03	−0.06**	−0.04*	0.14
Herfindahl index	−0.15**	−0.11**	−0.12**	−0.10
MDs/capita	4.17	35.71**	11.27*	71.00
North Central	0.07**	0.07**	0.06**	0.04
Northeast	0.03	5.47E-3	0.02	−0.25*
West	0.12**	0.08**	0.09**	0.30*
Selectivity variable	−0.07	−0.14**		
Chain membership			0.02*	
Area % primary MDs				0.26
Area % surgical MDs				0.03
Area % MDs 45–54				−6.2E-4**
Beds per capita				0.03
Unemployment rate				−0.46
Population				3.9E-5**
Area % age 65 or over				−0.03*
Area % Medicare discharges				0.13
Area % Medicaid discharges				−0.71
Area no. hospitals				−0.03
Area avg. income				1.4E-5
Hospital beds				−7.7E-4
Hospital occupancy				−0.78
Adjusted R^2	0.953	0.962	0.956	
N	919	1281	2200	2200

$^*p \le .05$.; $^{**}p \le .01$.

†Exponential notation.

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