PRE- AND POST-MERGER INVESTIGATION OF HOSPITAL MERGERS

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INTRODUCTION

In the late 1980s, hospital merger activity increased following the expansion of managed care plans and the implementation of Medicare's Prospective Payment System (PPS), which changed the reimbursement method from cost-based to case-based. Recent merger activity has occurred in a period when hospitals were less able to pass on higher costs to payers. In a market characterized by such an increased price competition, the most efficient firms are more likely to survive and others to fail. An increase in the number of mergers suggests that merging is a way to become more efficient to ensure long-run survival. In competitive markets, mergers may result in increased efficiency by exploiting scope and scale economies, or alternatively may lead to a gain in market power and a reduction in competition.

Although the Antitrust Division recognizes the efficiency-enhancing potential of mergers, determining the relevant market has been the most important step in the assessment of the hospital mergers in court cases. In 1988 and 1991, four hospital mergers in Roanoke, Virginia; Rockford, Illinois; Ukiah, California; and Augusta, Georgia were challenged by the Justice Department, and two were prevented from merging because they would have resulted in a significant increase in market concentration [Blackstone and Fuhr, 1992]. After the Antitrust challenges in 1988 and 1991, the number of hospital mergers declined, suggesting that hospitals feared antitrust challenges.

This study investigates the operating efficiencies of merged and control hospitals prior to the merger, and one and two years after the merger. The three-year span allows merging hospitals to identify and implement a cost efficiency program and achieve economies of scale and scope. I argue that the purpose of the merger activity in the late 1980s was to reduce production costs by achieving scope and scale economies through elimination of waste and redundancies, and duplicative units, thereby helping to ensure long-run survival. The American Hospital Association (AHA) data indicated that most hospitals involved in a merger or consolidation between 1987 and 1990 were located in or around the same metropolitan areas. Spatial interdependence between merging hospitals is a necessary condition for achieving operational efficiencies that are not available to geographically-dispersed hospitals in multi-hospital systems. Past research indicates that mergers of hospitals across geographic regions into multi-hospital systems produce efficiencies in purchasing, and access to capital and managerial skills; however, little is known about operating efficiencies in mergers which take place among hospitals in the same market area.

Scale efficiencies in the hospital industry may result because: (1) a hospital is too small to exploit economies of scale; (2) a hospital is too large, and is overcapitalized and underutilized. A merger can also achieve scope economies by utilizing the plant and equipment for an increased number of services.

Past merger studies focused on nationwide multihospital systems which used descriptive statistics and multivariate analysis [Manheim, Shortell and McFall, 1989; Mullner and Anderson, 1987; Levitz and Brooke, 1985; Coyne, 1985].[1] Recent studies of multiproduct hospital costs employed hybrid translog cost functions and provided well-grounded approach to hospital costs [Fournier and Mitchell, 1992; Eakin, 1991; Vita, 1990; Grannemann, Brown and Pauly, 1986; Conrad and Strauss, 1983; Cowing and Holtmann, 1983]. Sinay and Campbell [1995] employed a hybrid translog cost function to test for the presence of pre-merger scale economies for all mergers from 1987 to 1990 and found diseconomies of scale among merged hospitals.

This study makes several contributions to the merger literature. First, it examines merged hospitals and matching controls located in or around local markets instead of geographically dispersed multihospital system affiliations. Second, the study investigates the post-Prospective Payment System (PPS) period, a period of disequilibrium, with movement toward a new equilibrium path from increased market competition in the hospital industry. Third, this study employs a multiproduct cost function to measure relative efficiency among merged hospitals instead of previously-used single output structural or behavioral models.

EMPIRICAL FORMULATION

Baumol, Panzar and Willig [1982] defined the multiproduct cost concepts for scope and scale economies. Hospitals may obtain cost advantages in increasingly competitive health care markets through product specific economies of scale, ray economies of scale and economies of scope. In a two-product case, the degree of product-specific economies of scale for product one, S_1, is measured by

$$S_1=[C(Y_1,Y_2) - C(0, Y_2)] / [Y_1\ \delta C / \delta Y_1], \tag{1}$$

where Y_1 is the output level of product one, Y_2 is the output level of product two, and S_1 is the ratio of average incremental costs to marginal costs at Y_1. An S_1 greater (less) than one, indicates that average costs exceed (less than) marginal costs and there are economies (diseconomies) of scale.

Another way in which output may change to reduce costs is to move along a ray in output space, expanding or contracting all outputs proportionately. Ray economies of scale are an overall return to scale measure and are defined as the elasticity of output with respect to cost. At minimum average costs, the weighted sum of marginal costs is equal to the weighted sum of average costs. This can be measured by

$$S = C(Y) / \Sigma_i Y_i\ MC_i \qquad \text{for } i = 1,2. \tag{2}$$

An S greater than one (less than one) indicates that average cost exceeds (is less than) marginal cost, and there are economies of scale (diseconomies).

Savings from joint production are referred to as economies of scope. Economies of scope are present when the cost of producing two products jointly is less than the cost of producing them separately. A natural measure of the degree of scope economies is

$$S_c=[C(Y_1, 0) + C(0, Y_2) - C(Y_1, Y_2)] / C(Y_1, Y_2). \tag{3}$$

Another technique that measures the effects of scope makes use of cost complementarities. Cost complementarities are present when the marginal cost of producing one product decreases when the quantity of the other product is increased. For a twice, continuously differentiable cost function, cost complementarities exist if the expression

$$C_{ij} = \delta^2 C / \delta Y_i Y_j \text{ is negative where } i \neq j. \tag{4}$$

To estimate multiproduct scale and scope economies along with marginal costs, an explicit functional form must be selected. I chose a hybrid translog cost function. This takes the best features of both the structural and behavioral models, and allows the researcher to control for market conditions. The estimated cost function is

$$\begin{aligned} \text{Ln } C_v = {} & \alpha_o + \Sigma_i \alpha_i Y_i^* + \Sigma_i \Sigma_r \alpha_{ir} Y_i^* Y_r^* + \Sigma_j \beta_j \text{Ln } W_j + 1/2 \Sigma_i \Sigma_j \beta_{ij} \text{Ln } W_i \text{ Ln } W_j + \\ & \Sigma_i \Sigma_j \phi_{ij} Y_i^* \text{Ln } W_j + \varphi_k \text{Ln } BEDS + 1/2\, \varphi_{kk} (LNBEDS)^2 + \Sigma_i \mu_i Y_i^* \text{Ln } BEDS + \\ & \Sigma_j \delta_j \text{Ln } W_j \text{ Ln } BEDS + B_{serv}\ SERVMIX + B_{pro}\ PROFIT + B_{sys}\ SYSTEM + \\ & t\ YTREND + m\ METRO + r_2 REGION2 + r_3 REGION3 + r_4 REGION4 + \\ & r_5 REGION5 + r_6 REGION6 + \epsilon, \end{aligned} \tag{5}$$

where C_v is the total variable cost *(TOTCOST)*;[2] Y_i^* is a set of patient services-acute care *(TOTACU)*, intensive care *(TOTINTE)*, subacute care *(TOTSUB)* and outpatient visits *(TOTOUT)* where $Y^* = (Y^\tau - 1) / \tau$ and τ is the Box-Cox transformation parameter. Many of the hospitals in this study have zero values on some output categories and the natural log of zero is undefined. A Box-Cox transformation on output variables using the above expression permits zero outputs. When the estimated τ approaches zero, the Box-Cox transformation on output variables closely approximates the natural log transformation [Greene, 1990]; W_j is a set of input prices-average salary *(WAGE)* and average price of supplies *(SUPPLIES)*;[3] *BEDS* is the number of staffed beds in the hospital representing fixed capital; *SERVMIX* is the total number of services offered by the hospital;[4] *PROFIT* is a dummy variable of proprietary status; and *SYSTEM* is another dummy variable to control the effect of system affiliation on hospital costs. *METRO* controls for the size of the market where merging and control hospitals are located.[5] In the past, the highly populated geographic markets increased hospital costs due to intense nonprice competition. However, because nonprice competition is replaced by price competition following the PPS, this coefficient is expected to be negative to reflect the changing face of health care markets. The regional dummies *(REGION2..REGION6)* control for differences in regional economies [Longo and Chase, 1984].[6]

Because of the small number of hospitals merged or consolidated in any one year, I pooled four consecutive years of data and derived cross-sectional estimates for the 1987-1990 period. The pooling of data increased the sample size, allowing greater precision in the estimates. A year trend (*YTREND*) was used to distinguish differences in total variable costs over time.[7] All data were mean-scaled except for dummy variables. Monetary variables were deflated by the medical price index (1982-1984 = 100).[8] The hybrid translog cost function employed in this study is a short-run variable cost function, and the following homogeneity and symmetry conditions are imposed on the parameters:

$$\Sigma_j \Sigma \beta_j = 1 \qquad \Sigma_j \beta_{ij} = 0 \qquad \Sigma_j \phi_{ij} = 0 \qquad \Sigma_j \delta_j = 0.$$

Also, using Shepherd's Lemma, factor demand equations for two variable inputs, labor, and supplies can be derived. However, only one of the two factor demand equations is independent. Therefore, the share of input j, M_j, can be specified as follows:

$$(6)\quad M_j = \delta Ln\, C_v \,/\, \delta Ln\, W_j = \beta_j + \Sigma_j \beta_{ij} Ln\, W_j + \Sigma_i \Sigma_j \phi_{ij} Y_i^* + \delta_{jk} Ln\, BEDS.$$

A factor demand equation for labor was estimated along with equation (5) using seemingly unrelated regression (SUR). Ray economies of scale were obtained from the following expression, where $BEDS^*$ is the optimal level of beds [Vita, 1990].

$$(7)\qquad S = (1 - \delta Ln\, C_v \,/\, \delta Ln\, BEDS^*) \,/\, (\Sigma\, Output\ Cost\ Elasticities).$$

Scope economies were calculated by cost complementarities for a twice, continuously differentiable cost function as shown in expression (5). Marginal cost estimates can be obtained from the elasticity equations by multiplying by $C^\wedge / Y_i$, where $C^\wedge$ is the antilog of the right-hand side of equation (5).

Data for the analysis came from the AHA annual survey of U.S. hospitals. To control for structural change in the market, I chose a control hospital for each merging hospital based on four factors: location (MSAs), the number of staffed beds, system affiliation and not-for-profit status. First, I found several control hospitals for a merger partner from the same Metropolitan Statistical Area with similar bed size. Next, the system affiliation and not-for-profit status were matched using an elimination method. If a matching control hospital was not found, then a neighboring MSA was used to find a matching hospital controlling for the size of the MSA. Control and merging hospitals with missing or inconsistent data were followed up, and where possible, missing data were obtained and errors corrected from the previous year's data. If there was no output data reported for a merged hospital both one year and two years after the merger, I eliminated the merger (both merger partners prior to the merger) from the study. If this information was available in only one of two post merger years, then missing data were interpolated from the other year. This was done in a few occasions.[9]

TABLE 1
Descriptive Statistics of Merged and Control Hospitals Prior to the Merger

Variable	Merging Hospitals Mean	Merging Hospitals S.D.	Control Hospitals Mean	Control Hospitals S.D.	t-stat
Total Cost (000)	$26,127	32,410	$24,903	25,166	0.64
Acute care days	41,566	47,933	39,515	35,797	0.84
Intensive care days	5,121	8,192	5,154	6,788	-0.05
Subacute care days	5,126	10,721	6,888	12,757	-1.37
Outpatient visits	51,700	51,447	56,677	58,059	-1.00
Salary	$22,664	5,147	21,845	5,087	1.63
Supply price	$134	57	$129	63	0.77
Labor share	65%	7%	65%	6%	-0.84
Service mix	27	11	27	12	0.64
For profit	9%	29%	11%	31%	-0.71
System affiliated	48%	50%	45%	50%	0.56
Beds	211	184	212	161	-0.08
Metro size	2.90	2.09	3.28	2.00	-3.22[a]
Region I	21.4%	41.2%	21.4%	41.2%	
Region II	32.8%	47.1%	32.8%	47.1%	
Region III	11.5%	32.0%	11.5%	32.0%	
Region IV	11.5%	32.0%	11.5%	32.0%	
Region V	6.1%	24.0%	6.1%	24.0%	
Region VI	16.8%	37.5%	16.8%	37.5%	
Number of Hospitals	131		131		

a. Significant difference from control hospitals in the pre-merger period at the one percent level.

FINDINGS

Table 1 presents the descriptive statistics for the data on merging and matching control hospitals in the year prior to the merger. A paired sample t-test was used to determine significant differences between variable means for merging and control hospitals. At the one percent significance level, differences in variables between merging hospitals and controls were not significant except for the size of the geographic market. Some of the control hospitals were selected from neighboring locations due to the difficulties of finding matching hospitals in small MSAs. Therefore, on average, control hospitals come from larger market areas as shown by the average metro size of 3.28 for controls, in comparison to the 2.90 of merging hospitals. Matching criteria-staffed beds, system affiliation, and not-for-profit status were not statistically significant. Control hospitals produced more subacute care days and outpatient visits than merging hospitals whereas merging hospitals produced approximately 2,000 more acute care days than their counterparts in this period.

Table 2 presents the estimates of equation (5) using the hybrid translog cost function specification for merged hospitals for the pre-merger year, one year after and two years after the merger. A seemingly unrelated regression (SUR) algorithm was used to estimate these functions. Explanatory power of all three functions is high, as indicated by R^2s of .985, .989 and .986, respectively.[10] The seemingly unrelated regression is an efficient way of estimating pooled time series regression and permits the correction of first-order autoregression. This method treats each cross-section and the time series within that cross-section as a separate equation which is unrelated to any other cross-section in the pooled data set. This approach was developed by Zellner [1962] to manage the system of equations. The SUR estimators are consistent and more efficient than applying OLS to each cross section separately [Sayrs, 1989].

In the cost function estimates, first-order output coefficients are all positive and significant. This complies with the neo-classical view. Bed size is associated with higher variable costs among merging hospitals in the pre-merger period and lower variable costs in the post-merger period. In the pre-merger period, if an average merging hospital increased its bed size by one percent (2.11 beds, see Table 1), the variable cost would increase by 0.40 percent, approximately $104,508. On the other hand, two years after the merger, if a merged hospital increased its bed size by one percent (3.96 beds), total variable cost would decline by 0.25 percent which is approximately $135,335 (see Table 7). Variables such as service mix, for-profit status and systems affiliation have no effect on total variable costs of merging hospitals.[11] Even though the number of services does not explain the variation in costs for merging hospitals, two out of three times this coefficient is significant in the cost function estimates of control hospitals in Table 3. Unexpectedly, the size of the metropolitan area is positively associated with the variable cost indicated by the significant coefficient of the *METRO* variable two years after the merger for merging hospitals, and in the pre-merger period for controls. This is consistent with the non-price competition theory which was believed to be true only in the pre-PPS period. Finally, the merged hospitals located in the central states, including the Pacific and South Atlantic states, have lower costs than those located in the East Coast and Mountain regions in the pre-merger period. Namely, this can be explained by positive local economic factors in Florida and Georgia in the South Atlantic, and Washington and Oregon in the Northwest.

Estimated cost function parameters of control hospitals are revealed in Table 3 for pre-and post-merger periods. All first-order output cost elasticities are positive and significant. Bed size is always positively associated with the variable cost of control hospitals. In the pre-merger period, increasing beds by one percent (2.12 beds) elevated the total variable costs by 0.20 percent which is approximately $49,806. Following the merger, total costs increase by $37,224 and $59,623 as a result of a one percent increase in bed size. Most important, the positive coefficient of the beds in all three years indicate that the control hospitals are not in long-run equilibrium throughout the study period. The service mix is a cost-contributing factor for controls in two out of three years. Control hospitals in the West and East North Central States, and the Pacific region have higher variable costs one year after the merger. Control hospitals in the South Atlantic states also have higher costs two years after the merger.

TABLE 2
Estimated Cost Function Parameters of Merged Hospitals for Three Periods

VARIABLE	PARAMETER	Pre-Merger ESTIMATE	One Year After ESTIMATE	Two Years After ESTIMATE
Constant	α_0	-0.0114	-0.0067	-0.2496[a]
Totacu	α_1	0.3237[a]	0.7586[a]	0.7415[a]
Totinte	α_2	0.1244[a]	0.1580[a]	0.1464[a]
Totsub	α_3	0.0634[a]	0.1721[a]	0.1606[a]
Totout	α_4	0.1432[a]	0.0841[a]	0.0624[b]
(Totacu)^2	α_{11}	0.0533[a]	-0.3483[b]	0.1657
(Totinte)^2	α_{22}	0.0122[a]	0.0290	-0.0049
(Totsub)^2	α_{33}	0.0057[a]	0.0224[a]	0.0468[a]
(Totout)^2	α_{44}	0.4516	-0.4996	-0.4390[a]
Totacu×totinte	α_{12}	-0.0244	-0.0217	-0.0660
Totacu×totsub	α_{13}	-0.0550[a]	-0.1849[a]	-0.2557[a]
Totacu×totout	α_{14}	0.0375	0.1552	0.3373[a]
Totinte×totsub	α_{23}	-0.0026	-0.0203	-0.0329
Totinte×totout	α_{24}	-0.0123	-0.0201	0.0018
Totsub×totout	α_{34}	0.0078[b]	-0.0206	0.0130
Wage	β_1	0.6438[a]	0.6330[a]	0.6381[a]
Supplies	β_2	0.3562[a]	0.3670[a]	0.3619[a]
(Wage)^2	β_{11}	0.1762[a]	0.1944[a]	0.1763[a]
(Supplies)^2	β_{22}	-0.0500[a]	-0.0402[a]	-0.0033
Wage×supplies	β_{12}	-0.1262[a]	-0.1542[a]	-0.1796
Wage×totacu	ϕ_{11}	-0.0149[a]	0.0286[b]	0.0116
Wage×totinte	ϕ_{12}	0.0038	0.0025	0.0159[a]
Wage×totsub	ϕ_{13}	-0.0001	-0.0063	-0.0228[a]
Wage×totout	ϕ_{14}	0.0241[a]	0.0185[b]	0.0091
Supplies×totacu	ϕ_{21}	-0.0466	0.2079[b]	-0.2359[a]
Supplies×totinte	ϕ_{22}	0.0182	-0.0758	0.1276[a]
Supplies×totsub	ϕ_{23}	-0.0297[a]	-0.0907[a]	0.0088
Supplies×totout	φ_{24}	0.0452	-0.0847	0.0857
Beds	φ_k	0.3974[a]	-0.1773[b]	-0.2529[a]
(Beds)^2	φ_{kk}	0.0002	-0.5908[a]	-0.2028
Totacu×beds	μ_1	-0.0610	0.5422	-0.3886[b]
Totinte×beds	μ_2	0.0174	0.1449	0.1959[a]
Totsub×beds	μ_3	0.0579[a]	0.2399[a]	0.2569[a]
Totout×beds	μ_4	-0.0840[b]	-0.1727	-0.3570[a]
Beds×wage	δ_{k1}	-0.0011	-0.0457[a]	-0.0161
Beds×supplies	δ_{k2}	0.0011	0.0457[a]	0.0161
Servmix	B_{ser}	0.0470	-0.0227	0.0645
Profit	B_{pro}	-0.0146	0.0170	-0.0801
System	B_{sys}	0.0159	-0.0131	0.0172
Box-Cox P.	τ	0.1146[a]	0.3161[a]	0.4417[a]
Year trend	t	-0.0080	0.0163[b]	0.0062
Metro size	m	0.0130	-0.0131	0.0387[a]
Region 2	r_2	-0.0877[a]	0.0425	0.1006[a]
Region 3	r_3	-0.1840[a]	0.1563[a]	0.0186
Region 4	r_4	-0.1502[a]	-0.0747	-0.0087
Region 5	r_5	-0.0178	0.0275	0.0685
Region 6	r_6	-0.1488[a]	0.0272	0.0289
R^2		0.985	0.989	0.986

a. Statistically significant at the 5 percent level.
b. Statistically significant at the 10 percent level.

TABLE 3
Estimated Cost Function Parameters of Control Hospitals for Three Periods

VARIABLE	PARAMETER	Pre-Merger ESTIMATE	One Year After ESTIMATE	Two Years After ESTIMATE
Constant	α_0	-0.1552[a]	-0.3563[a]	-0.1744[a]
Totacu	α_1	0.4373[a]	0.4602[a]	0.3800[a]
Totinte	α_2	0.0923[a]	0.0793[a]	0.1199[a]
Totsub	α_3	0.0568[a]	0.1035[a]	0.1116[a]
Totout	α_4	0.1361[a]	0.1205[a]	0.0763[a]
$(Totacu)^2$	α_{11}	0.0309	0.2211[a]	0.0248
$(Totinte)^2$	α_{22}	0.0258[a]	-0.0057	0.0157[b]
$(Totsub)^2$	α_{33}	0.0052	0.0180[a]	0.0108[a]
$(Totout)^2$	α_{44}	0.2196	0.4619[b]	-0.3530
Totacu×totinte	α_{12}	-0.0566[a]	-0.1707[a]	-0.0379
Totacu×totsub	α_{13}	-0.0821[a]	-0.0848[a]	-0.1125[a]
Totacu×totout	α_{14}	0.0560[a]	-0.1186[a]	0.0712[a]
Totinte×totsub	α_{23}	-0.0151[a]	-0.0594[a]	0.0081
Totinte×totout	α_{24}	-0.0211	0.0525[b]	-0.0335
Totsub×totout	α_{34}	0.0129[b]	0.0175	0.0026
Wage	β_1	0.6441[a]	0.6389[a]	0.6382[a]
Supplies	β_2	0.3559[a]	0.3611[a]	0.3618[a]
$(Wage)^2$	β_{11}	0.1327[a]	0.1414[a]	0.1541[a]
$(Supplies)^2$	β_{22}	-0.0326[a]	-0.0322[a]	-0.0662[a]
Wage×supplies	β_{12}	-0.1001[a]	-0.1092[a]	-0.0879[a]
Wage×totacu	ϕ_{11}	0.0112	-0.0131[b]	-0.0028
Wage×totinte	ϕ_{12}	0.0041	0.0128[a]	0.0011
Wage×totsub	ϕ_{13}	-0.0019	-0.0078[a]	-0.0035[a]
Wage×totout	ϕ_{14}	0.0248[a]	0.0227[a]	0.0207[a]
Supplies×totacu	ϕ_{21}	-0.0203	-0.1333[a]	-0.1476[a]
Supplies×totinte	ϕ_{22}	-0.0150	0.0498	0.0568[b]
Supplies×totsub	ϕ_{23}	-0.0171[a]	0.0202[a]	-0.0303[a]
Supplies×totout	ϕ_{24}	0.0142	0.0487	0.1056
Beds	φ_k	0.1954[a]	0.1451	0.2272[a]
$(Beds)^2$	φ_{kk}	-0.2836[a]	-0.5153[a]	-0.4103[a]
Totacu×beds	μ_1	0.1782[a]	0.1129	0.2654[a]
Totinte×beds	μ_2	0.0687	0.2700[a]	0.0232
Totsub×beds	μ_3	0.0947[a]	0.1458[a]	0.1282[a]
Totout×beds	μ_4	-0.2099[a]	-0.1304[a]	-0.0605
Beds×wage	δ_{k1}	-0.0360[a]	-0.0137	-0.0166[b]
Beds×supplies	δ_{k2}	0.0360[a]	0.0137	0.0166[b]
Servmix	B_{ser}	0.1208[a]	0.1591[a]	0.1280[a]
Profit	B_{pro}	0.0542	0.0360	0.0521
System	B_{sys}	-0.0079	-0.0245	-0.0126
Box-Cox P.	τ	0.2093[a]	0.2388[a]	0.1792[a]
Year trend	t	0.0015	0.0378[a]	0.0143
Metro size	m	0.0307[a]	0.0115	-0.0117
Region 2	r_2	-0.0400	0.0762[a]	-0.0197
Region 3	r_3	-0.0488	-0.0056	-0.0644
Region 4	r_4	0.0155	-0.0133	0.0491[a]
Region 5	r_5	0.0109	0.0629	0.0563
Region 6	r_6	0.0370	0.0672[b]	0.0250
R^2		0.989	0.986	0.987

a. Statistically significant at the 5 percent level.
b. Statistically significant at the 10 percent level.

Estimated Ray Economies of Scale

As a first step in assessing potential gains in efficiency from a merger, ray economies of scale were computed, using parameter estimates from Tables 2 and 3. Diseconomies of scale in merging hospitals and economies of scale in control hospitals in the pre-merger period were found when the cost function was evaluated at variable means. Scale economies are .9204 for merging hospitals and 1.1197 for the control hospitals (see Table 4). Increasing all hospital services by one percent would increase total variable costs by 1.09 percent (1/0.9204) for merging hospitals and .89 percent (1/1.1197) for control hospitals. These results are consistent with those of Sinay and Campbell [1995]. Scale economies were also calculated for high volumes of acute care services—2 times mean—and for low volumes of output—1/2 the mean-for acute care days. Larger volume hospitals are associated with diseconomies in comparison to significant economies of small hospitals. Standard error estimates are derived as a linear combination of estimated parameters are shown in parentheses, and are available upon request.

During the four year investigation of scale economies, merging hospitals revealed diseconomies of scale in the pre-merger period, no economies or diseconomies of scale one year after the merger and economies of scale two years after the merger. By eliminating duplicative units, waste and redundancies, merged hospitals achieved significant efficiencies during this period. This is consistent with the operating efficiency hypothesis. On average, scale economies of merged hospitals improved to 1.0038 one year after and 1.1197 two years after the merger.

Control hospitals consistently showed moderate economies of scale from pre-merger to the post-merger period. The ray economies of scale for control hospitals were 1.1136 in the pre-merger period, and were 1.1197 and 1.1234 one year and two years after the merger, respectively. These results suggest that merged hospitals differed from control hospitals in terms of operating costs and efficiency measures. As a result, hospitals that merged in this period could become more efficient by proportionately reducing all outputs. On the other hand, matching control hospitals in the same local market area have a much greater potential to achieve lower costs by expanding all outputs.

Estimated Scope Economies

Scope economies are calculated for merging hospitals and matching controls, and results are shown in Table 5.[12] Economies of scope are present in merging hospitals between acute care and subacute care, indicated by negative and statistically significant value of C_{ij} in the pre-merger period and two years after the merger. Control hospitals also reveal the presence of scope economies between these two services which suggests that increased joint production of acute and subacute care services would lower costs in both merging and control hospitals. In contrast, merging and control hospitals showed the existence of diseconomies of scope between acute care and outpatient visits, and subacute care and outpatient visits for the pre-merger period and two years after the merger. However, the diseconomies of scope are no longer significant between subacute care and outpatient visits two years after the merger.

TABLE 4
Estimated Ray Economies of Scale for Merged and Control Hospitals

MERGED HOSPITALS-Prior to the Merger

	TOTACU	TOTINTE	TOTSUB	TOTOUT	S	
1/2 the mean	20,783	5,121	5,126	51,700	1.1828[a]	(0.28)
Sample mean	41,566	5,121	5,126	51,700	0.9204[a]	(0.19)
2 times mean	83,132	5,121	5,126	51,700	0.6127[a]	(0.14)
	One Year After the Merger					
1/2 the mean	37,249	10,858	18,650	117,749	1.6796[a]	(0.48)
Sample mean	74,498	10,858	18,650	117,749	1.0038[a]	(0.10)
2 times mean	148,996	10,858	18,650	117,749	0.5440[a]	(0.27)
	Two Years After the Merger					
1/2 the mean	34,613	11,086	22,915	132,223	1.4780[a]	(0.35)
Sample mean	69,225	11,086	22,915	132,223	1.1278[a]	(0.09)
2 times mean	138,450	11,086	22,915	132,223	0.7392[a]	(0.12)

CONTROL HOSPITALS-Prior to the Merger

	TOTACU	TOTINTE	TOTSUB	TOTOUT	S	
1/2 the mean	19,758	5,154	6,888	56,677	1.8619[a]	(0.23)
Sample mean	39,515	5,154	6,888	56,677	1.1136[a]	(0.05)
2 times mean	79,030	5,154	6,888	56,677	0.5570[a]	(0.10)
	One Year After the Merger					
1/2 the mean	17,810	5,616	10,900	66,673	2.0031[a]	(0.30)
Sample mean	35,619	5,616	10,900	66,673	1.1197[a]	(0.14)
2 times mean	71,238	5,616	10,900	66,673	0.4944[a]	(0.12)
	Two Years After the Merger					
1/2 the mean	17,121	5,753	9,551	74,073	1.9194[a]	(0.78)
Sample mean	34,241	5,753	9,551	74,073	1.1234[a]	(0.16)
2 times mean	68,482	5,753	9,551	74,073	0.5287[a]	(0.12)

a. Statistically significant at the one percent level.

Merged hospitals do not show any significant scope economies one year after the merger whereas control hospitals reveal significant scope economies between acute care and intensive care, and intensive care and subacute care in this period, along with significant diseconomies of scope between the pairs of intensive care/outpatient visits and subacute care/outpatient visits. Although the inconsistency in scope estimates from the pre-merger period to one year after the merger is hard to explain, this could be the result of consolidating two or more organizations into one in a short period of time. Therefore, the results of the cost function estimates for one year after the merger should be evaluated with caution.

TABLE 5
Estimated Scope Economies for Merged and Control Hospitals

	MERGERS		CONTROLS	
Services	Economies of Scope	Standard Error	Economies of Scope	Standard Error
	Prior to the Merger			
Acute/Intensive	0.0159	0.0229	-0.0162	0.0307
Acute/Subacute	-0.0345[a]	0.0187	-0.0572[a]	0.0198
Acute/Outpatient	0.0839[a]	0.0364	0.1155[a]	0.0239
Intensive/Subacute	0.0053	0.0039	-0.0100	0.0076
Intensive/Outpatient	0.0055	0.0125	-0.0085	0.0162
Subacute/Outpatient	0.0169[a]	0.0058	0.0206[a]	0.0070
	One Year After the Merger			
Acute/Intensive	0.0982	0.1082	-0.1342[a]	0.0410
Acute/Subacute	-0.0543	0.0619	-0.0372	0.0289
Acute/Outpatient	0.2190	0.1470	-0.0631	0.0406
Intensive/Subacute	0.0069	0.0273	-0.0512[a]	0.0170
Intensive/Outpatient	-0.0068	0.0621	0.0621[b]	0.0320
Subacute/Outpatient	-0.0061	0.0318	0.0300[a]	0.0117
	Two Years After the Merger			
Acute/Intensive	0.0426	0.0871	0.0077	0.0289
Acute/Subacute	-0.1366[a]	0.0615	-0.0701[a]	0.0266
Acute/Outpatient	0.3836[a]	0.0995	0.1002[a]	0.0359
Intensive/Subacute	-0.0094	0.0265	0.0215[a]	0.0092
Intensive/Outpatient	0.0109	0.0460	-0.0244	0.0288
Subacute/Outpatient	0.0230	0.0246	0.0111	0.0110

a. Statistically significant at the 5 percent level.
b. Statistically significant at the 10 percent level.

Marginal Cost Estimates

The marginal cost of four output categories can be derived from parameter estimates of the hybrid translog cost function. Table 6 presents the marginal cost estimates for each output category in the pre- and post-merger periods. For the merged hospitals, the marginal cost of an additional patient day is about 42 percent lower in acute care services, but 36, 50 and 15 percent higher in the production of intensive care, subacute care and outpatient visits than in controls, respectively. One year after the merger, the merged hospitals lost their cost advantage in providing an additional acute care day as compared to control hospitals, but they were able to lower the marginal cost of an outpatient visit to $40. In the same period, control hospitals decreased the marginal cost of intensive care from $441 to $340. The same control hospitals reduced the marginal cost of outpatient visits from $59 to $44, with a moderate increase in the marginal cost of acute care and subacute care days. Merged

TABLE 6
Marginal Cost Estimates for Merged and Control Hospitals

Services	Pre-Merger Period	One Year After	Two Years After
		Merged Hospitals	
Acute Care	$192	$571	$534
Intensive Care	$599	$816	$659
Subacute Care	$305	$517	$350
Outpatient Visits	$68	$40	$24
		Control Hospitals	
Acute Care	$273	$311	$749
Intensive Care	$441	$340	$534
Subacute Care	$203	$228	$299
Outpatient Visits	$59	$44	$26

hospitals in the same period showed dramatic increases in the marginal cost of acute, intensive and subacute care days due to the short-term effects of the merger.

Two years after the merger, merged hospitals appear to have much lower marginal costs for four services in comparison to those one year after the merger, whereas the marginal costs of acute, intensive and subacute care services of control hospitals showed moderate increases. However, the control hospitals stayed very competitive in the market place in terms of providing intensive and subacute care, and outpatient visits revealing lower marginal costs for intensive and subacute care days. Also, control hospitals showed dramatic increases in the volume of outpatient visits. It is clear that there was intense competition in the market for outpatient services, which provided referrals for inpatient services. The marginal cost of outpatient visits has declined about 180 percent among merged hospitals and 127 percent among control hospitals from pre-to post-merger period.

CONCLUSION

The results of this study show that the hospital merger activity in the late 1980s reduced the cost of production by achieving scale and scope economies, allowing hospitals to become more efficient. In a four-year pooled sample (1987-1990), merged hospitals completed a transition form diseconomies of scale in the pre-merger period to economies of scale two years after the merger. This is consistent with the operational efficiency hypothesis. One year after the merger is not sufficient time to achieve efficiencies as indicated by relatively high marginal costs. In addition, scope economies are evident in merging and control hospitals in acute and subacute care services in the pre-merger period and two years after the merger, providing another possible reason for consolidation.

TABLE 7
Post-Merger Descriptive Statistics of Merged and Control Hospitals

	MERGERS		CONTROLS	
Variable	One Year After Mean	Two Years After Mean	One Year After Mean	Two Years After Mean
Total Cost (000)	54,971	54,134	25,672	26,266[a]
Acute Care Days	74,498	69,225[a]	35,619	34,241[b]
Subacute Care Days	18,650	22,915[a]	10,900	9,551[a]
Outpatient Visits	117,749	132,223[a]	66,673	74,043[a]
Service Mix	42	45[a]	31	34[a]
System Affiliated	63%	57%[a]	50%	50%
Beds	405	396[b]	206	206
Metro Size	2.94	3.03[b]	3.26	3.31

a. Significant at the one percent level.
b. Significant at the 10 percent level.

One of the important findings of this paper is that merged hospitals were different from control hospitals prior to the merger. The merged hospitals revealed significant pre-merger diseconomies as opposed to the scale economies of control hospitals. This suggests that merged hospitals needed to reduce all inpatient days proportionately. In contrast, the control hospitals needed to increase all outputs proportionately to achieve efficiencies. Marginal cost estimates support these findings that merging and control hospitals had a different cost structure in the pre-merger period. Two years after the merger, the marginal costs of merged and control hospitals for each service category appeared to converge, reflecting the impact of market competition.

The post-merger descriptive statistics show that merged hospitals substituted subacute care days for more costly acute care days and reduced excess beds significantly. On the other hand, the control hospitals produced less acute and subacute care days, and revealed a significant increase in total cost (see Table 7). Average salary reduction is also notable, though not significant, in merged hospitals. In addition, the number of services provided significantly increased in both merged and control hospitals, indicating a trend toward providing a full set of services to obtain managed care contracts.

Further research may enhance the results of this study by computing individual scope and scale estimates for each hospital in the sample. Also, analyzing individual service categories by bed size; acute, intensive and subacute care; and the part-and full-time hospital personnel from pre-to post-merger periods would determine the sources of operating efficiencies achieved.

NOTES

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1. The complete list of articles used in the literature review can be provided upon request.
2. C_v is the total variable cost which consists of labor and supply costs. Labor cost includes total payroll expenses, employee benefits and professional fees. Supply costs are defined as all other operating expenses.
3. The average salary *(WAGE)* is computed by dividing total labor cost by the FTE. Average price of supplies *(SUPPLIES)* is obtained by dividing total supply cost by adjusted inpatient days.
4. Longo and Chase [1984] showed that the service diversification is an important determinant for a merger or closure using total number of facilities or services at hospitals. Although the case-mix index is a better measure of severity of patients, it was not available for this study.
5. In the AHA data, the size of the metropolitan areas is classified into six groups: 0 = non-metropolitan area, 1 = under 100,000 population, 2 = 100,000 to 250,000, 3 = 250,000 to 500,000, 4 = 500,000 to 1,000,000, 5 = 1,000,000 to 2,500,000, 6 = over 2,500,000.
6. From the AHA classification, six regions are created as follows: Region1 = New England and Mid Atlantic states, Region2 = East North Central and West North Central states, Region3 = East South Central and West South Central states, Region4 = South Atlantic states, Region5 = Mountain region, Region6 = Pacific states.
7. Although a fixed-effects specification to control for time-invariant differences across hospitals would be appropriate, due to low degrees of freedom in the post-merger period, the year trend is preferred over separate year dummies to increase the degrees of freedom by two. The fixed-effects model was also estimated for merged and control hospitals for the pre-and post-merger periods, and estimated coefficients were not changed significantly from the results reported in this paper. Changes in coefficients range from 0.001 in the pre-merger period and two years after the merger to 0.01 one year after the merger.
8. The medical price index is originally calculated by the Department of Labor and published in the Economic Report of the President [1994]. This index is used because of higher price increases in the medical field that cannot be fully explained by a CPI index. The medical care price index is a combination of medical care commodities and medical care services.
9. Hospitals with missing data in the pre-and post-merger periods caused a loss of total 71 hospitals from the pre-merger data set. The final sample contained 131 pre-merger hospitals and 63 post-merger hospitals along with their controls. This does not generate any selection bias against these estimates. Sinay and Campbell [1995] used the full-data set and reported pre-merger results for the 1987-1990 period. They found diseconomies of scale at the same magnitude as those of the merged hospitals included in this study.
10. The short-run cost functions are estimated along with the labor demand equations for each period. The R^2s of demand equations vary from 39 percent to 74 percent from the pre-merger to the post-merger periods. These labor demand equations are not reported here but available upon request. Also, the high R^2s of estimated cost functions mean either an excellent fit or an overfit due to the utilization of a large number of variables, interaction terms and multicollinearity among them. The difference between these two outcomes can be detected from the number of statistically significant coefficients. In this study, the number of significant coefficients and high R^2s are similar to those found in the most recent studies.
11. The variable PROFIT explains the existence of only for-profit-hospitals in the sample. All other hospitals such as state, federal, church and non-profit hospitals enter the model as zero.
12. The Cowing and Holtmann [1983] and Vita [1990] studies provide decomposition of the scope estimates.

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