Hospital Consolidation and Costs: Another Look at the Evidence

David Dranove and Richard Lindrooth[1]

Northwestern University

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Abstract: We investigate whether two-to-one hospital mergers lead to short-term cost savings. We use a unified empirical methodology, so that we may directly compare results for systems (where hospitals share ownership but maintain separate licenses) and mergers (where hospitals share the same license). Our comparison group consists of a group of ten 'pseudo mergers' that were chosen using nearest neighbor matching based on a propensity score. Estimates of a multi-product cost function reveal that hospitals that form systems do not enjoy any measurable cost reductions. On the other hand, mergers that lead to closure (or conversion) of one of the inpatient facilities offer considerable savings two, three and four years out– our point estimates range from 6-9 percent. Mergers that do not lead to closures appear to decrease costs in the first-year, by an estimated 5 percent. However, after three or four years, there is no longer a significant reduction in costs. The results are robust to changes in the specification and the sample. We also present some evidence that the distance between merger partners is inversely related to cost savings.

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Hospital Consolidation and Costs: Another Look at the Evidence

1. Introduction

The introduction of the Medicare Prospective Payment System in 1983, followed by the rapid growth of managed care among privately insured individuals, have placed enormous fiscal pressure on hospitals. Dranove et al. (2001) show that hospitals responded to this pressure by consolidating with local competitors. Hospital executives hope that consolidation generates efficiencies. But insurers fear that consolidation increases hospital market power and hospital prices without any offsetting cost reductions.

Thus far, the empirical evidence on consolidation efficiencies is mixed, and the research methods have been inconsistent. Two recent studies reach seemingly conflicting conclusions about consolidation. Dranove and Shanley (1995) and Dranove, Durkac and Shanley (1996) (henceforth DDS) report that costs in multihospital *systems* in California were similar to the costs of independent hospitals in the state. Using nationwide sample of hospitals that *merged* between 1986 and 1994, Connor, Feldman and Dowd (1997, 1998) (henceforth CFD) report that costs in merging hospitals declined relative to the costs of hospitals that did not merge.

In this paper, we investigate these findings using improved methods and up-to-date data. We describe fundamental distinctions between system acquisitions and mergers to explain why we might expect different results. At the same time, we use a unified empirical methodology, so that we may directly compare results for systems and mergers. Our methods attempt to address many problems overlooked in previous studies. Based on estimates of a multi-product cost function, we find that hospitals that form systems do not enjoy any measurable cost reductions as late as four years post-acquisition. On the other hand, mergers that lead to closure (or conversion) of one of the inpatient facilities offer considerable savings – our point estimates range from 6-8 percent**.** Mergers that do not lead to closures decrease costs two years post-merger by an estimated 5 percent, but do not appear to be associated with significant cost decreases in subsequent years. Thus, only mergers that lead to closures appear to have a lasting effect on costs.

2. Background and related research

Prior to the 1990s, hospital consolidation usually involved acquisitions by national systems such as the Hospital Corporation of America and Humana. These national systems acquired hospitals scattered throughout the United States, so that they rarely achieved local consolidation efficiencies. In the last decade, hospitals began to consolidate with local competitors.[2] Local consolidation has taken two forms. In local multi-hospital systems (henceforth, "systems"), two or more hospitals in the same geographic market have common ownership, but maintain separate physical facilities, do business under separate licenses, and keep separate financial records. In local mergers (henceforth, "mergers") two or more hospitals in the same local market have common ownership, do business under a single license, report unified financial records, and possibly consolidate some physical facilities.

Whether forming systems or merging, consolidating hospitals publicly tout the potential efficiency gains. But when responding to surveys, hospital executives are often

[2] Dranove et al. (forthcoming) show that this consolidation was largely a response to the growth of managed care.

skeptical about the benefits, and those executives who have been directly involved in consolidation are sometimes the most skeptical.[3] Several recent empirical studies of hospital systems and mergers have not fully answered the question of whether consolidation generates efficiencies.

Examining two different cross-sections (1988 and 1991), DSS compare the performance of thirteen local systems in California with the performance of "pseudosystems" – aggregations of independent hospitals matched to the actual systems. They find virtually no differences in either cross-section between actual and pseudo systems in terms of costs or offerings of high tech services. However, they find that actual systems had higher prices and higher profit margins.[4]

Connor, Feldman and Dowd (CFD) study local hospital mergers across the entire United States over a period of nine years. They regress changes in average hospital costs and prices against a variety of predictors, including whether the hospital has recently merged. They find that hospitals that have merged experience smaller cost increases than those that have not. They also find that the magnitude of the cost increase depends on characteristics of the merging hospitals and their markets. For example, hospitals whose merger partners have many overlapping services tend to experience slower relative cost increases than do hospitals whose merger partners have few overlapping services.

At first blush, the results of DSS and CFD seem to be in conflict. The former seems to find that consolidation does not reduce costs. The latter disagrees. However,

[3] See Greene (1990, 1992) and Colon et al. (1999)

[4] Menke (1997) examines a cross-section of over 2000 hospitals in 1990 to determine whether hospitals in both local and national systems had lower costs than did independent hospitals. She finds that the typical system hospital had lower average costs than did the typical independent hospital, after controlling for case-mix, patient severity, and local wages. However, her findings are very sensitive to functional form.

there are two important differences in these studies that suggest that the results may not be inconsistent.

First, the two studies examine different forms of consolidation. When it comes to hospitals, mergers are not the same as systems, and we should not expect the same results. At first blush, it is somewhat difficult to distinguish mergers from systems. In both, independent hospitals combine under common ownership. Thus, both DSS consolidations and CFD consolidations would qualify as mergers in the general business sense of the term. However, the term merger has a unique definition in health care. Hospital mergers involve the combination of separate facility licenses into a single license. Merged hospitals report a single set of financial and utilization statistics, and are regulated as a single entity (for example, for the purposes of certificate of need.)

Because of the financial reporting and regulatory implications, there may be important differences between mergers and systems. For example, consider independent hospitals wishing to shift inpatient services across facilities. By merging and effectively operating under a single license, hospitals may bypass a myriad of state regulations. Thus, we might expect that mergers would be associated with elimination of services, and therefore would generate larger savings. On the other hand, hospitals that do not intend to eliminate services may not find it necessary to merge. In the extreme, a merger may result in a hospital closure. This might lead to substantial cost savings, unless the patients and services are shifted to the surviving facility, and there is no reduction in fixed costs. In our empirical analysis, we distinguish among three forms of consolidation: systems, mergers, and mergers leading to closures.

A second critical difference between DSS and CFD is that the former perform cross-section studies, whereas the latter is a pre-post study. This could explain the seemingly inconsistent results; for example, it could be that consolidating hospitals have above average costs prior to consolidation, and average costs afterwards. This suggests that both DSS and CFD could be marred by sample selection bias. The potential bias in DSS's cross-section study is readily apparent. Even though CFD use differenced data, it is not immune from bias either. CFD take differences over a nine-year period. Within a period of nine years many unobserved factors that are potentially correlated with the merger decision and costs may change, leading to bias in the estimate of the effect of merger, despite the use of differences. Furthermore, the effect is exasperated by the use of all other hospitals as a comparison group, as this admits a wide range of hospital sizes, locations, and case mixes as a comparison group to each merger.

In this paper, we perform a pre-post analysis using a common time period for all mergers. Like DSS, we randomly match hospitals with similar characteristics and create ten pseudo-mergers for the comparison group of each real merger. We choose our control group such that unmeasured shocks are expected to affect both merged and comparison hospitals similarly. Changes in costs are measured over a four-year period for all systems and mergers, and we use the same four-year window for each real and matched pseudo-merger. Four-year differences allow us to control for more unmeasured heterogeneity than is possible when nine-year differences are used. However, it does imply that we will not capture long-term merger savings. We also control for mean regression. This is important, because mergers may have higher than expected costs in the pre-merger period, which may be correlated with the merger decision.

3. Methods

We follow CFD and perform a pre-post study. To limit bias, we follow DSS and match each consolidating pair with a sample of "pseudo-consolidating" hospitals. The latter are drawn from the sample of all hospitals that do not undergo consolidation during the same time period when the consolidation occurred, and are matched using a propensity score. We model the probability of merging using a Probit and match hospitals that merge to the ten closest hospitals that did not merge based on the predicted probability ("propensity") of merging (e.g. Todd, 1999). See the Appendix for the results of the specification of the probability of merging.

The use of propensity score matching allows us to control for selection on observable characteristics. For example, if mergers were more likely to occur in markets with high managed care growth/penetration then we might over-estimate the effect of the merger on cost-reduction because we'd expect a tendency towards cost reduction even without the merger. However, we do not seek to control for selection on unobservable characteristics such as the quality of the fit of the two hospitals. In fact, it would be undesirable to do so because we seek estimates of the effect of self-selected mergers.

After the hospitals are matched we aggregate the data for each matched pair to create a "pseudo merger". Prior to merger, the observations of each hospital are also combined into the merged entity so we have a consistent unit of observation. If the merged entity is truly integrated it should be operating off of the same cost function after the merger.

Consistent with previous studies of consolidations, including DSS, CFD, and Menke (1997), we estimate a cost function. We use a translog multi-product specification and control for hospital specific characteristics such as case-mix, patient mix, demographics, and ownership. The log of total operating costs of hospital i in period t is modeled as follows:

$$\ln(c_{it}) = \alpha + \sum_m \alpha_m \ln(y_{mit}) + 0.5 * \sum_m \sum_n \beta_m \ln(y_{mit}) \ln(y_{nit}) + \alpha_w \ln(w_{it}) + \beta_w \ln(w_{it}) \ln(w_{it}) + \sum_k \delta_k k_{kit} + \beta_\chi \chi_{it} + \lambda_i + \varepsilon_{it} \quad (1)$$

where: y_{mit} is the output at hospital i in year m in category m (m = inpatient or outpatient); w_{it} is the average wage of hospital employees in the market served by hospital i in period t; k_{kit} indexes the type of merger (k=system, merger, merger/closure); χ_{it} is a vector of hospital market characteristics; λ_i is a hospital fixed effect; α, β, δ are parameters to be estimated; and ε_{it} is a normally distributed error. Note $y_{...} = y_{\text{hospital 1}} + y_{\text{hospital 2}}$ in the pre-period for all consolidations and in the pre and post period for pseudo consolidations.

Mean regression is often a problem in pre-post studies of hospital costs. Consider that there are often substantial fixed costs in the short run (Friedman and Pauly, 1981). Thus, a hospital that has a higher than expected patient census in one year will, as a result, enjoy lower than expected average costs that year. However, that hospital should expect an increase in average costs the next year, merely due to random fluctuations in volume. We follow Dranove and Cone (1985) to control for mean regression. In period 0 (pre-merger) hospital costs can be represented by the following equation

$$\ln(c_{i0}) = \alpha + \sum_m \alpha_m \ln(y_{mi0}) + 0.5 * \sum_m \sum_n \beta_m \ln(y_{mi0}) \ln(y_{ni0}) + \alpha_w \ln(w_{i0}) + \beta_w \ln(w_{i0}) \ln(w_{i0}) + \beta_\chi \chi_{0t} + \lambda_i + \varepsilon_{i0}. \quad (2)$$

Similarly, period 1 (post-merger) hospital costs are

$$\ln(c_{i1}) = \alpha + \sum_m \alpha_m \ln(y_{mi1}) + 0.5 * \sum_m \sum_n \beta_m \ln(y_{mi1}) \ln(y_{ni1}) + \alpha_w \ln(w_{i1})$$
$$+ \beta_w \ln(w_{i1}) \ln(w_{i1}) + \sum_k \delta_k k_{ki1} + \beta_\chi \chi_{i1} + \lambda_i + \varepsilon_{i1}. \quad (3)$$

Mean regression implies the errors (i.e. unexplained cost components) are auto-correlated:

$$\varepsilon_{i1} = \gamma \varepsilon_{i0} + \mu_{i1}. \quad (4)$$

thus we can express the difference in costs as:

$$\ln(c_{i1}) - \ln(c_{i0}) = \alpha + \sum_m \alpha_m \Delta \ln(y_{mi}) + 0.5 * \sum_m \sum_n \beta_m \Delta[\ln(y_{mi}) \ln(y_{ni})]$$
$$+ \alpha_w \Delta \ln(w_i) + \beta_w \Delta[\ln(w_i) \ln(w_i)] + \sum_k \delta_k k_{ki} + \beta_\chi \Delta \chi_i + (\gamma - 1)\varepsilon_{i0} + \mu_{i1}. \quad (5)$$

Equation (5) represents the key estimation equation in our analysis. We use a median regression because it is less sensitive to outliers. We have outliers in our data that we believe are due to measurement error in the Medicare Cost report. However, since we cannot be completely sure this is the case, we estimate the median response rather than the average response using OLS. In doing so, we do not throw out observations on the basis of our subjective judgment about the validity of the data. The standard errors are calculated using a bootstrap with 500 repetitions. There is no need to adjust for smearing using a median regression because of the quantile regression's invariance to monotonic transformations property.

We check whether our results are robust to change in the specification and estimation technique. We estimate the model without the regression to the mean component; using OLS; without quadratic and interaction terms on the inputs and output; excluding hospital characteristics; with beds modeled as a quasi-fixed input; and excluding system acquisitions. We also test whether the cost changes associated with each merger type vary by pre-period market concentration and the year of the merger. We do this by interacting Herfindahl thresholds indicators (<33 percentile and <66 percentile) with the merger indicator variables. We interact an indicator of whether the merger occurred before 1993 with the merger indicator variables. In addition, we estimated Equation 5 using a two, three, and four year follow-up period.

Finally, we assess whether the results differ by the distance between the two merged entities. To do so we create a series of dummy variables that equals one if the merged hospitals were within 3, 5, and 10 miles of one another respectively. We then interact the dummy variable with the merger indicator variables and re-estimate the model for each degree of separation.

4. Data

The primary dataset is the American Hospital Association's (AHA) Annual Survey of Hospitals (1988-1998) supplemented by financial information from the Medicare Cost Report. We use the Medicare Cost Report in place of the AHA Annual Survey when there was no response in the AHA's Annual Survey. The dataset also includes demographic information from the Area Resource File (ARF) and HMO penetration data corrected for the 'home office' reporting problem in the ARF.[5] We created the analysis dataset as follows.

First, we restrict attention to combinations of two independent hospitals into a single merged entity or system. We begin by identifying all two-to-one mergers and system consolidations consummated between 1989 and 1997. We then restricted our attention to consolidations in the same metropolitan area (i.e., the same "local market.")

[5] This refers to the fact that HMO enrollment data reported in the ARF is based on the location of the HMO's home office, rather than the location of the enrollees. We thank Douglas Wholey for making these data available.

This represents our sample of consolidating hospitals. To form a comparison group, we match non-consolidating hospitals (which include independent hospitals as well as hospitals that may have consolidated prior to 1988) to consolidating hospitals using a propensity score as discussed above.

Next, we created ten pseudo-consolidations among the ten matched comparison hospitals. We limited the sample to those hospitals that reported complete cost data to the AHA or the Medicare cost report one year before and two years after the consolidation. There were 110 consolidations of 220 hospitals that had complete data for the entire two, three and four year follow-up period. We also estimate the model using a sample that includes consolidations with complete data in any of the three follow-up periods. In this larger sample there are 172 consolidations of 344 hospitals two years after merger, 146 consolidations of 292 hospitals three years after merger, and 112 consolidations of 224 hospitals four years after mergers. The fall off occurs largely because the dataset is truncated for the mergers in later years: the difference is not due to attrition.

It is important to distinguish between mergers in which both facilities remain open and mergers in which one facility subsequently closes or converts to another use. The latter may generate substantially greater cost reductions as allocated fixed costs (and, potentially, some variable costs) are eliminated. To identify closures, we examined the listing of addresses contained in the AHA Directory of hospitals.[6] In most cases following a merger, the directory lists the addresses of both facilities. We treat these as cases in which both facilities remain open. In 16.1 percent of the cases for which we had

[6] We could rule out the possibility of consolidations leading to closure because in such an event, the closed hospital would no longer exist in the data.

complete data, the directory no longer lists the address of one of the facilities. We treat this as a closure. We confirmed the identity of closures by examining the hospital's web site or contacting them by phone. In a little more than half of the cases, one of the buildings was converted to medical-related use that was not inpatient hospital care, in the remaining cases one of the buildings was no longer being used for healthcare related purposes. In addition to identifying consolidation status, we include several control variables in our estimation of equation (5). These are listed in Table 1. We imputed the values of the independent variables if they were missing in one of the periods in either the consolidation or comparison group. The majority of the imputed values were the number of Medicaid/Medicare admissions used to compute Medicaid or Medicare share (about 15% of the observations for these variables).

5. Results

Table 2 reports summary statistics for our data. The data are broken down into two sets of columns. The first set reports pre- and post-consolidation summary statistics for the actual consolidating hospitals. The second set reports the pre- and post-consolidation for the pseudo-consolidations. There are number of other noteworthy facts in Table 2. First, despite the use of propensity score matching, the matched hospitals appear to be bigger than the hospitals that actually merge. Second, the number of inpatient and outpatient visits rises significantly more rapidly among the comparison hospitals.

Table 3 reports the base differences and the difference in differences by merger type. There is no significant difference between system acquisition and the matched comparison mergers for the majority of variables. Only changes in market wage and for-profit status are significantly different at actual consolidations compared to pseudo-consolidations. The changes in inpatient admissions, ER visits, Medicare share, Medicaid share, and Medicare case-mix were significantly less than the comparison group at mergers that did not result in closure. Changes in costs, the number of inpatient visits, the number of outpatient visits, the number of ER visits, Medicare share, and Medicaid share were all significantly less than the comparison group at mergers then closures.

Our key findings appear in Table 4, which presents several specifications of the cost regressions. The bootstrapped standard errors appear in parentheses. The first set of results is based on an unbalanced sample of all mergers. Only mergers/closures are estimated to lead to a significant reduction in costs, about –7% two years after and –8% four years after merger. The point estimate of the four-year savings for mergers/no closure is large (-.071) but not statistically significant. The second set of results is based on the balanced sample of hospitals with data for a full four years post-merger. In the balanced sample all types of mergers appear to lead to cost savings after two years. System acquisitions lead to about a 3.7% drop in costs, mergers/no closure lead to about a 5.3% reduction in costs, and mergers/closure lead to about an 8.4% reduction in costs. Only the cost reductions at mergers/closure appear to be consistent over time. After three years the cost reduction is about 6.2% (p-value 0.105) and after four years about 7.9%.

Coefficients on control variables are generally in line with expectations. Increases in wages, Medicare and Medicaid shares are usually associated with higher costs. Increases in for-profit ownership (presumably due to conversion) and HMO penetration are associated with lower costs.

The results of the alternative specifications are in Table 5. The specifications in columns 1, 2-5 all yield results that are either identical to, or very close to, the results presented in Table 4. Merger/Closures lead to larger and consistent cost savings over time. Column 2 lists the results for the OLS estimation. OLS yields dramatic cost savings for both merger/no closures and merger/closure after four years. These results are greater than the median regression due to outliers. The outliers are due to dramatic changes in expenditures in a handful of hospitals in either the actual merger group or the comparison group. If we eliminate these few outliers the results are quite similar to the median regression results. Column 6 shows the results of the median regressions excluding system acquisitions and including one dummy variable for both merger/no closure and merger/closure. The specification is closest to that of CFD. We see that failure to differentiate between the type of merger can lead to negative and significant merger effects on costs for all types of mergers. However, as we see in Table 4, the cost-reducing effects are only realized by mergers/closures. We also interacted the level of the baseline HHI (i.e. <0.33 or <0.66) and the timing of the merger (i.e. pre-1993) with the merger coefficients. The results (not reported here) revealed that neither interaction is significant.

Table 6 summarizes the distance between merger partners by type of merger. It is clear from the Table that system acquisitions tend to have partners that are farther apart that the other types of consolidation. In contrast, partners in mergers/closures appear to be relatively close to each other with 86% of the partners within 3 miles of each other.

Clearly the incentive to consolidate activities is much greater, the closer the merger partners are together.

To investigate this further we interacted a dummy variable indicating the distance between merger partners with the consolidation indicator variables. The results of this specification are in Table 7. We find significantly larger cost reductions for system acquisitions that are either within 3, 5, and 10 miles. However, these cost reductions are still not significantly different from zero. We find similar results for merger/no closures, except that merger/no closures within ten miles show significantly reduced costs. We did not perform a similar specification for merger/closure since the majority of the partners are within 3 miles. The results are suggestive that distance between merger partners may be highly correlated with cost reductions. The mechanism by which the cost reductions occur is the degree the hospitals integrate.

Discussion

Hospitals have responded to the rise of managed care by consolidating at an unprecedented pace. Merger proponents have hoped that consolidation would lower costs. Prior to this study, the literature on hospital consolidation has yielded inconsistent evidence about cost savings. We build on prior studies by using consistent data and methods and correcting for several potential sources of bias and heterogeneity. Overall, we find significant savings for mergers that lead to closures, and smaller (but insignificant) savings for other types of consolidation. There is some evidence suggesting that mergers led to larger savings when the two hospitals were nearby, but even then the savings are statistically insignificant.

Our results contradict those of Conner, Feldman, and Dowd (1997, 1998), who found that mergers were associated with cost savings. We can identify several other reasons why our results on mergers differ from those of CFD. First, we separate merger/closures from other mergers. The former are associated with substantial savings, and help improve the apparent performance of the average merger. Second, we examine more recent data. CFD found that later mergers generated smaller efficiencies than did mergers in the 1980s, so our results may be an extension of this trend. Third, we examine one-to-one mergers, whereas CFD study all mergers, even those involving the acquisition of a single hospital by a large system. We believe that ours is a cleaner approach, as we would not expect the same benefits on a per-hospital basis when a large system acquires a single hospital. Fourth, we estimate a translog cost function, which may do a better job of controlling for changes in patient load and patient mix. Fifth, we study a consistent time window from one year prior to two years post merger. CFD examine a nine-year period without regard for when hospitals merged within that period. While our window admittedly limits us to finding short-term merger effects, the CFD window seems *ad hoc*. While their window enables them to capture long run cost reductions at hospitals that merged early on, it also counts as merger savings any cost reductions realized prior to merger by hospitals that did not merge until the end of their window.

Our findings confirm what many hospital executives involved in consolidation have already expressed. Hospital consolidation does not lead to savings on a consistent basis. This raises the question of why hospitals consolidate, if not to reduce costs. An obvious alternative explanation is that hospitals consolidate to raise prices paid by managed care payers. There are no studies to date that examine the effects of consolidation on managed care prices, however. If such evidence does emerge, it would be difficult for hospitals to justify consolidation as pro-competitive.

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Table 1: List of Variables, Definitions, and Sources

Variable	Definition	Source
Hospital costs	Real total operating expense	AHA Annual Survey & Medicare Cost Report
Inpatient admissions	Total hospital inpatient admissions	AHA Annual Survey
SNF admissions	Total facility SNF/LTC inpatient admissions	AHA Annual Survey
Outpatient visits	Total outpatient visits (excluding ER)	AHA Annual Survey
ER visits	Total emergency room visits	AHA Annual Survey
Medicaid share	Medicaid share of total discharges	AHA Annual Survey
Medicare share	Medicare share of total discharges	AHA Annual Survey
Percent births	Births as a percent of total admissions	AHA Annual Survey
Wages	Real average hospital wage in the market	AHA Annual Survey
For-profit	For-profit ownership	AHA Annual Survey
Non-federal government	Non-federal government ownership	AHA Annual Survey
Teaching	Presence of a residency program	AHA Annual Survey
Case-mix index	Medicare cost report index	Medicare Cost Report
HMO Penetration	Percent HMO enrollees in market	ARF, corrected for 'home office' reporting
Per capita income	Market level per capita income	ARF
Mean regression measure	Residual from cross-section estimate of costs	Estimated

Table 2. Summary Statistics of Balanced Sample

	Consolidations (n=110)				Pseudo Consolidations (n=1100)			
	Pre	Post			Pre	Post		
	~2 year	~2 year	~3 year	~4 year	~2 year	~2 year	~3 year	~4 year
Total Operating Costs ($1000s)	927.871	988.159	998.702	1021.970	1088.512	1198.666	1238.024	1291.184
	(766.305)	(839.874)	(852.638)	(926.605)	(805.509)	(874.109)	(914.518)	(974.277)
Number of Inpatient Admissions (100s)	146.069	140.995	141.257	141.996	169.097	168.824	171.436	177.406
	(105.150)	(103.542)	(104.405)	(108.473)	(102.147)	(104.194)	(108.027)	(112.747)
Number of SNF Admissions (100s)	0.854	1.625	2.206	2.407	0.995	1.643	2.066	2.224
	(1.939)	(2.831)	(3.686)	(4.142)	(1.928)	(2.849)	(3.407)	(3.602)
Number of Outpatient Visits (100s)	371.235	453.768	478.814	496.146	417.654	570.879	615.165	672.143
	(336.983)	(441.117)	(496.465)	(470.463)	(389.009)	(522.675)	(574.894)	(577.071)
Number of ER Visits (100s)	156.936	158.068	150.777	156.649	166.449	179.808	184.217	191.472
	(103.726)	(110.235)	(103.390)	(109.944)	(91.310)	(100.255)	(104.603)	(103.832)
Medicaid Share of Inpatient Days	0.251	0.210	0.195	0.205	0.273	0.300	0.304	0.293
	(0.125)	(0.123)	(0.120)	(0.115)	(0.146)	(0.149)	(0.155)	(0.151)
Medicare Share of Inpatient Days	0.799	0.620	0.617	0.619	0.771	0.826	0.840	0.856
	(0.195)	(0.271)	(0.265)	(0.272)	(0.168)	(0.180)	(0.184)	(0.184)
Percent of Births	0.114	0.116	0.113	0.113	0.117	0.114	0.113	0.112
	(0.057)	(0.060)	(0.055)	(0.052)	(0.060)	(0.058)	(0.058)	(0.056)
Market Hospital Wage (Logged)	240.169	246.993	249.177	245.813	238.495	248.437	249.054	248.553
	(41.243)	(44.754)	(51.882)	(45.487)	(37.650)	(40.201)	(39.620)	(40.050)
For-Profit Hospital	0.123	0.155	0.164	0.155	0.132	0.135	0.130	0.137
	(0.255)	(0.357)	(0.359)	(0.350)	(0.244)	(0.242)	(0.241)	(0.244)
Non-federal Government Hospital	0.141	0.150	0.127	0.123	0.148	0.146	0.146	0.144
	(0.296)	(0.336)	(0.306)	(0.297)	(0.262)	(0.258)	(0.268)	(0.262)
Teaching Hospital	0.259	0.264	0.273	0.282	0.327	0.324	0.334	0.340
	(0.350)	(0.399)	(0.404)	(0.404)	(0.341)	(0.343)	(0.348)	(0.355)
Medicare Case-mix	1.286	1.364	1.378	1.382	1.313	1.362	1.377	1.382
	(0.151)	(0.195)	(0.203)	(0.201)	(0.161)	(0.178)	(0.182)	(0.183)
HMO penetration rate	0.130	0.161	0.189	0.207	0.124	0.159	0.178	0.195
	(0.124)	(0.150)	(0.160)	(0.165)	(0.086)	(0.108)	(0.114)	(0.115)
Per capita income	18861.690	21733.920	22745.420	23778.020	18670.360	21447.000	22416.000	23448.370
	(4099.439)	(4814.509)	(5087.887)	(5288.594)	(3193.294)	(3762.301)	(4002.367)	(4155.756)

Note: Balanced Sample

Table 3. Differences between four years post and two years before merger, by merger type

Variable	System Acquisitions			Mergers/No Closure			Mergers/ Closures		
	Difference	Comparison Difference	Difference in Difference	Difference	Comparison Difference	Difference in Difference	Difference	Comparison Difference	Difference in Difference
Total Operating Costs	176,337.60	147,562.70	-28,774.96	77,424.97	187,674.80	110,249.80	-34,394.66	213,309.50	247,704.10**
	(366915.000)	(276873.000)	(42432.560)	(267229.200)	(359539.300)	(59167.640)	(157767.500)	(257103.000)	(57218.450)
Number of Inpatient Admissions	525.73	471.58	-54.15	-999.21	399.91	1399.120*	-1,529.89	126.53	1656.418*
	(3910.500)	(3435.613)	(516.273)	(1946.045)	(3638.929)	(591.401)	(2304.562)	(2955.333)	(664.707)
Number of SNF Admissions	169.74	107.90	-61.84	162.26	114.15	-48.10	107.90	154.15	46.24
	(317.694)	(267.969)	(40.461)	(287.814)	(299.329)	(50.101)	(260.162)	(303.212)	(68.592)
Number of Outpatient Visits	14,252.56	20,526.17	6,273.61	11,195.35	27,059.92	15,864.57	10,703.66	28,847.61	18143.950*
	(34926.980)	(37656.590)	(5550.376)	(40217.840)	(53756.930)	(8849.506)	(23346.120)	(37740.880)	(8401.628)
Number of ER Visits	1,009.11	1,706.27	697.16	-713.97	1,975.54	2689.501*	-1,227.06	2,442.74	3669.793**
	(5133.580)	(4636.541)	(694.621)	(3423.767)	(6558.085)	(1065.143)	(3399.854)	(4711.179)	(1055.437)
Medicaid Share of Inpatient Days	0.016	0.015	-0.001	-0.118	0.028	0.147**	-0.062	0.031	0.094**
	(0.094)	(0.127)	(0.018)	(0.094)	(0.123)	(0.020)	(0.127)	(0.113)	(0.026)
Medicare Share of Inpatient Days	0.090	0.083	-0.007	-0.416	0.089	0.505**	-0.385	0.099	0.485**
	(0.140)	(0.135)	(0.020)	(0.118)	(0.122)	(0.020)	(0.158)	(0.102)	(0.025)
Percent of Births	-0.008	-0.006	0.002	0.002	-0.007	-0.009	0.012	-0.004	-0.016
	(0.046)	(0.042)	(0.006)	(0.034)	(0.040)	(0.007)	(0.036)	(0.030)	(0.007)
Market Hospital Wage (Logged)	-9.584	10.694	20.278**	18.187	8.183	-10.004	18.014	10.745	-7.269
	(39.322)	(34.290)	(5.157)	(40.289)	(32.044)	(5.519)	(54.351)	(31.002)	(7.711)
For-Profit Hospital	0.080	0.014	-0.066**	-0.026	0.012	0.037	0.024	0.017	-0.007
	(0.234)	(0.122)	(0.020)	(0.228)	(0.121)	(0.023)	(0.249)	(0.102)	(0.028)
Non-federal Government Hospital	0.000	-0.015	-0.015	-0.026	0.010	0.036*	-0.048	-0.005	0.043
	(0.175)	(0.106)	(0.017)	(0.160)	(0.094)	(0.017)	(0.269)	(0.069)	(0.024)
Teaching Hospital	0.040	0.018	-0.022	-0.013	0.001	0.014	0.048	0.007	-0.040
	(0.170)	(0.163)	(0.024)	(0.314)	(0.201)	(0.036)	(0.218)	(0.216)	(0.049)
Medicare Case-mix	0.076	0.064	-0.013	0.127	0.067	-0.060**	0.089	0.083	-0.006
	(0.090)	(0.077)	(0.012)	(0.119)	(0.077)	(0.014)	(0.106)	(0.083)	(0.019)
HMO penetration rate	0.076	0.069	-0.007	0.076	0.076	0.000	0.083	0.065	-0.019
	(0.131)	(0.067)	(0.011)	(0.100)	(0.068)	(0.012)	(0.089)	(0.072)	(0.017)
Per capita income	23,883.46	22,952.59	-930.87	23,152.02	24,180.41	1,028.39	24,689.54	23,269.32	-1,420.22
	(5280.669)	(4006.714)	(613.561)	(4197.440)	(4141.825)	(696.430)	(6998.100)	(4351.447)	(1062.665)

Notes: ** Significant at 1% Level; * Significant at 5% Level. Balanced Sample

Table 4. Median Regression of Cost Function

	Unbalanced			Balanced (Observations in all three periods)		
Follow-up	2 years	3 years	4 years	2 years	3 years	4 years
Constant	0.149***	0.189***	0.238***	0.176***	0.208***	0.237***
	(0.011)	(0.014)	(0.026)	(0.014)	(0.018)	(0.025)
Merger Variables						
System Acquisition	-0.015	0.013	0.008	-0.038**	0.007	0.011
	(0.021)	(0.023)	(0.027)	(0.019)	(0.020)	(0.027)
Merger/ No closure	-0.018	0.008	-0.071	-0.054*	-0.008	-0.045
	(0.024)	(0.033)	(0.046)	(0.031)	(0.037)	(0.049)
Merger/ Closure	-0.076***	-0.045	-0.088**	-0.088**	-0.064	-0.082**
	(0.024)	(0.043)	(0.041)	(0.037)	(0.040)	(0.041)
Hospital Inpatient Admissions	-0.538*	-0.233	0.886*	-0.357	-0.429	0.948*
	(0.276)	(0.336)	(0.535)	(0.458)	(0.438)	(0.541)
Hospital Inpatient Admissions, Squared	0.069***	0.026	0.001	0.097***	0.036	-0.003
	(0.023)	(0.024)	(0.038)	(0.028)	(0.028)	(0.037)
SNF Admissions	0.018	0.014	0.015	-0.025	0.013	0.014
	(0.029)	(0.024)	(0.038)	(0.032)	(0.030)	(0.037)
SNF Admissions, Squared	0.000	-0.002**	0.001	-0.002	-0.002**	0.001
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Outpatient Admissions	0.247**	0.162*	0.094	0.098	0.117	0.074
	(0.097)	(0.088)	(0.154)	(0.151)	(0.128)	(0.149)
Outpatient Admissions, Squared	0.005	0.014***	0.024***	0.005	0.015***	0.023***
	(0.003)	(0.005)	(0.006)	(0.004)	(0.005)	(0.007)
ER Admissions	0.025	-0.149	-0.142	0.122	-0.122	-0.197
	(0.270)	(0.223)	(0.331)	(0.340)	(0.287)	(0.308)
ER Admissions, Squared	0.054**	0.017	0.030	0.069**	0.018	0.026
	(0.025)	(0.019)	(0.028)	(0.028)	(0.020)	(0.027)
ER*SNF	0.002	0.002	-0.002	0.004	0.002	-0.002
	(0.005)	(0.004)	(0.007)	(0.006)	(0.005)	(0.007)
ER*Outpatient	-0.043**	-0.030*	-0.021	-0.019	-0.031*	-0.013
	(0.022)	(0.016)	(0.022)	(0.026)	(0.017)	(0.023)
Outpatient*SNF	-0.003	-0.005*	-0.004	0.000	-0.006**	-0.004
	(0.003)	(0.002)	(0.004)	(0.004)	(0.003)	(0.004)
Hospital*SNF	0.001	0.004	0.005	0.001	0.005	0.005
	(0.004)	(0.003)	(0.006)	(0.005)	(0.004)	(0.006)
Hospital*Outpatient	0.008	-0.014	-0.037*	0.001	-0.009	-0.041**
	(0.016)	(0.014)	(0.020)	(0.021)	(0.016)	(0.020)
Hospital*ER	-0.060	0.019	-0.018	-0.126***	0.014	-0.014
	(0.041)	(0.035)	(0.055)	(0.038)	(0.038)	(0.052)
Medicaid Share	0.072**	0.055	0.064*	0.085**	0.058	0.072*
	(0.028)	(0.034)	(0.039)	(0.036)	(0.036)	(0.041)
Medicare Share	0.048*	0.097**	0.067	0.005	0.066	0.074
	(0.026)	(0.039)	(0.046)	(0.038)	(0.049)	(0.046)
For-profit Hospital	-0.078**	-0.087*	-0.110**	-0.062	-0.046	-0.108**
	(0.035)	(0.045)	(0.049)	(0.038)	(0.045)	(0.047)

Continued on next page

Table 4. Median Regression of Cost Function (continued)

	Unbalanced			Balanced (Observations in all three periods)		
Follow-up	2 years	3 years	4 years	2 years	3 years	4 years
Non-federal Gov Hospital	-0.012	-0.074	-0.017	0.001	-0.094	-0.020
	(0.033)	(0.047)	(0.055)	(0.050)	(0.066)	(0.058)
Teaching Hospital	0.007	0.013	-0.007	-0.005	0.001	-0.006
	(0.020)	(0.018)	(0.028)	(0.021)	(0.018)	(0.024)
Case-mix index	0.192***	0.246***	0.226***	0.179***	0.230***	0.239***
	(0.042)	(0.050)	(0.073)	(0.062)	(0.059)	(0.074)
Per Capita Income	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HMO Penetration	-0.325***	-0.350***	-0.286***	-0.489***	-0.333***	-0.315***
	(0.045)	(0.048)	(0.066)	(0.058)	(0.054)	(0.066)
Wage	1.429*	2.340**	1.717	0.219	1.913	1.715
	(0.795)	(0.982)	(1.309)	(1.365)	(1.317)	(1.258)
Wage, Squared	-0.118	-0.198**	-0.138	-0.010	-0.158	-0.138
	(0.072)	(0.089)	(0.119)	(0.125)	(0.119)	(0.114)
Cost data from MCR	-0.018**	-0.036***	-0.053***	-0.023**	-0.039***	-0.048***
	(0.009)	(0.010)	(0.014)	(0.011)	(0.011)	(0.014)
Period 1 residual	-0.148***	-0.198***	-0.218***	-0.144***	-0.191***	-0.219***
	(0.020)	(0.026)	(0.029)	(0.026)	(0.033)	(0.031)

Notes: *** Significant at 1% Level ; ** Significant at 5% Level; * Significant at 10% Level. Robust standard errors in parentheses

Table 5. Alternative Specifications

	1	2	3	4	5	6
Two years post						
System	-0.030	-0.023***	-0.031	-0.031	-0.038**	N/A
	(0.022)	(0.005)	(0.021)	(0.025)	(0.017)	
Merger/No closure	-0.050	-0.066***	-0.041	-0.036	-0.044	-0.032
	(0.031)	(0.018)	(0.029)	(0.024)	(0.028)	(0.030)
Merger/ Closure	-0.089**	-0.061***	-0.078*	-0.104***	-0.061*	N/A
	(0.041)	(0.016)	(0.044)	(0.027)	(0.032)	
Three years post						
System	-0.003	-0.011	0.011	0.003	0.007	N/A
	(0.024)	(0.007)	(0.023)	(0.022)	(0.022)	
Merger/No closure	0.005	-0.013	0.001	-0.029	-0.010	-0.029
	(0.035)	(0.025)	(0.038)	(0.031)	(0.039)	(0.038)
Merger/ Closure	-0.049	-0.054*	-0.080*	-0.106***	-0.031	N/A
	(0.042)	(0.026)	(0.042)	(0.034)	(0.043)	
Four years post						
System	0.015	0.012	0.006	0.012	0.003	N/A
	(0.031)	(0.011)	(0.025)	(0.027)	(0.022)	
Merger/No closure	-0.067	-0.137***	-0.044	-0.044	-0.056	-0.081*
	(0.049)	(0.040)	(0.051)	(0.044)	(0.046)	(0.046)
Merger/ Closure	-0.065	-0.212***	-0.074*	-0.063	-0.062*	N/A
	(0.045)	(0.032)	(0.040)	(0.042)	(0.038)	

1) Median regression w/o regression to the mean
2) Ordinary Least Squares Estimate
3) Excluding quadratic and interacted outputs
4) Excluding Medicaid and Medicare Share of patients, ownership dummies, and case-mix
5) Short-run cost function (total beds quasi-fixed input)
6) Mergers only with no closure and closure combined

Notes: *** Significant at 1% Level ; ** Significant at 5% Level; * Significant at 10% Level.
Balanced Sample

Table 6. Distance Between Merger Partners

	Base	Within 3 miles	Within 5 miles	Within 10 miles
System	50 (100%)	9 (18%)	9 (18%)	16 (32%)
Merger/No closure	39 (100%)	18 (46%)	25 (64%)	30 (77%)
Merger/ Closure	21 (100%)	18 (86%)	20 (95%)	20 (95%)

Number of mergers, percent in parentheses. Calculated using balanced sample.

Table 7. Results by Distance Between Mergers, four years post

	Base	Less than 3 miles	Less than 5 miles	Less than 10 miles
Four years post				
System	0.011	0.031	0.038	0.039
	(0.027)	(0.026)	(0.027)	(0.026)
System*Distance Dummy		-0.104*	-0.111*	-0.118*
		(0.059)	(0.060)	(0.066)
Sum of Parameters		-0.070	-0.073	-0.079
Merger/No closure	-0.045	-0.055	0.018	0.018
	(0.049)	(0.055)	(0.060)	(0.049)
Merger/ No Closure*Distance Dummy		0.028	-0.097	-0.104*
		(0.072)	(0.068)	(0.057)
Sum of Parameters		-0.061	-0.079	-0.086*
Merger/ Closure	-0.082**	N/A[1]	N/A[1]	N/A[1]
	(0.041)			
Merger/Closure*Distance Dummy		-0.076	-0.092**	-0.095***
		(0.056)	(0.037)	(0.036)

Notes: *** Significant at 1% Level; ** Significant at 5% Level; * Significant at 10% Level.
Bootstrapped standard error in parentheses.
1: Mergers/Closure beyond 3, 5, or 10 miles are excluded from the equation.

Appendix 1. Results of Probit Analysis of Probability of Merging

Constant	-6.633***
	(1.517)
Total Admissions (logged)	0.363
	(0.366)
Total Admissions (logged) , squared	-0.025
	(0.024)
Total Outpatient Visits (logged)	0.694**
	(0.315)
Total Outpatient Visits (logged), squared	-0.031**
	(0.015)
Medicaid Share	-0.142
	(0.218)
Medicare Share	-0.099
	(0.210)
For-Profit Hospital	-0.014
	(0.066)
Non-federal Government Hospital	-0.129**
	(0.057)
Teaching Hospital	0.106*
	(0.058)
Medicare Case mix	0.237
	(0.156)
System Membership	-0.096**
	(0.042)
Total Beds (logged)	-0.273
	(0.311)
Total Beds (logged), squared	0.022
	(0.033)
Skilled nursing unit	0.012
	(0.053)
Urban	-0.024
	(0.076)
Per capita Income	0.000**
	(0.000)
Population Density	0.000*
	(0.000)
Pct population greater than 65	-0.453
	(0.657)
HMO Penetration	0.097
	(0.199)
Number of hospital in market	-0.003***
	(0.001)
Distance to closest hospital	-0.035***
	(0.004)
Total Beds in Market	0.045
	(0.067)
Market-level case-mix	-0.280
	(0.278)

Includes year dummies; ***, **, * Significant at 1, 5, 10% level, respectively.