

# Hospital Merger Benefits: An Econometric Analysis Revisited

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## I. INTRODUCTION

In 2017 and 2019 we conducted analyses of the effects of hospital acquisitions on hospitals' costs and quality of care. Our research, which included both structured interviews with hospital leaders and econometric analysis, found that hospital acquisitions can generate substantial benefits.<sup>2</sup> In our interviews, the leaders of systems identified several mechanisms through which acquisitions may reduce costs, including by increasing hospital scale, standardizing clinical practices, and reducing the hospitals' cost of capital or allowing hospitals to avoid duplicative capital expenditures. Hospital leaders also noted the potential to realize substantial benefits in clinical quality attributable to the standardization of clinical protocols, investments to upgrade services at acquired hospitals, recruitment or deployment of additional staff to the acquired hospital, and concentrating the offering of complex services at a smaller number of service sites. The potential benefits identified by hospital leaders were evident in our analyses of the actual effects of hospital acquisitions on hospitals' costs, revenues, and quality indicators. We found that changes in the annual operating expenses of acquired hospitals were lower than those of comparable non-acquired hospitals, and that these decreases in expenses were accompanied by declines in revenue per admission. We also found evidence that measures of inpatient quality at acquired hospitals improved relative to comparable non-acquired hospitals.

In this report we revisit our econometric analysis and include two additional years of data for 2018 and 2019 on cost, quality, and revenue outcomes from hospital transactions.<sup>3</sup> The addition of these data allows us to measure the effects of 144 additional hospital acquisitions and also allows us to measure the effects of the hospital acquisitions we had previously included in our studies over a longer period of time. In total, our most recent analysis expands the data we use to include approximately 6,000 additional hospital-year observations. Using these new data, our updated results reinforce the conclusions of our previous reports: hospital acquisitions benefit patients by providing access to higher-quality care at a lower cost.

- Consistent with our previous analyses, hospital acquisitions are associated with a statistically significant 3.3 percent reduction in annual operating expenses per admission at acquired hospitals.
- At the same time, performance on key indicators of quality is improved: our empirical analysis continues to show a statistically significant reduction in inpatient readmission rates and a composite readmission/mortality outcome measure. Mortality rates at acquired hospitals also decline, but not by a statistically significant amount. The lack of statistical significance of the mortality outcome may be related to the inclusion of recent hospital transactions in our analyses; for recent transactions, it is difficult to measure quality improvements over the short post-acquisition time period reflected in our data.

1. The authors are economists at Charles River Associates. The conclusions set forth herein are based on independent research and publicly available material. The views expressed herein are the views and opinions of the authors and do not reflect or represent the views of Charles River Associates or any organizations with which the authors are affiliated. Financial support was provided by the American Hospital Association.

2. Monica Noether and Sean May. Hospital Merger Benefits: Views from Hospital Leaders and Econometric Analysis. January 2017; Monica Noether, Sean May, and Ben Stearns. Hospital Merger Benefits: Views from Hospital Leaders and Econometric Analysis – An Update. September 2019.

3. This additional data allows us to study recent hospital acquisitions that occurred between 2009 and 2019. To our knowledge, this study represents the most comprehensive analysis of contemporary hospital acquisitions.

- Revenue per admission at acquired hospitals also decline relative to non-merging hospitals by a statistically significant 3.7 percent. These results are suggestive that savings that accrue to merging hospitals are passed on to health plans.

Finally, the additional data we use in this update allow for several extensions of our original analyses that follow the approaches used in peer-reviewed studies of hospital acquisitions.<sup>4</sup> The results of these extensions are consistent with our original analysis and provide support for our primary results.

## II. QUANTITATIVE ANALYSES OF THE COST AND QUALITY EFFECTS OF HOSPITAL ACQUISITIONS

We follow the methods of our previous research to update our empirical analyses of the cost and quality effects of hospital acquisitions. These analyses compare cost per admission, revenue per admission, and inpatient quality measures for hospitals that have been acquired with the same measures for similar hospitals that have not been recently acquired. For our 2019 analyses, we compiled a database of all non-federal short-term acute care hospital acquisitions in the United States between 2009 and 2017.<sup>5</sup> While we use the same general approach as in our previous study, our updated analyses include hospital acquisitions that occurred between 2018 and 2019. In addition to being able to study the effects of additional hospital acquisitions, the longer time period included in our present study provides us with a longer period of cost, quality, and revenue data with which to evaluate the effects of hospital acquisitions that occurred between 2009 and 2017.

Our results using this expanded dataset reinforce our previous conclusions related to operating expenses and net patient revenue per admission. Previously, we reported that acquisitions were associated with a 2.3 percent reduction in operating expense per admission at the acquired hospitals. Our updated results indicate that these acquisitions were associated with a statistically significant 3.3 percent reduction in operating expense per admission at the acquired hospitals.<sup>6</sup> These estimates are larger in magnitude than our previous estimates and provide *additional evidence that the reductions in operating expenses at acquired hospitals are long-term rather than transitory*. In addition, we continue to find that acquisitions are also associated with a statistically significant reduction in net patient revenue per admission.<sup>7</sup>

We also continue to find that hospital acquisitions lead to improved performance on important quality indicators: our updated results show statistically significant improvements for a readmission quality measure and a composite readmission/mortality quality measure at acquired hospitals. While our estimate of the effect of acquisitions on mortality rates at acquired hospitals is similar in magnitude to our previous estimates, the effect is no longer statistically significant. However, as we discussed in our previous reports, the mortality measure reflects the outcomes for Medicare beneficiaries with only three conditions—acute myocardial infarction, heart failure, and pneumonia—and reflects an outcome for which it may be difficult to adjust for differences in patients’ comorbidities and severity of illness that contribute to mortality risks. As we noted in our previous work, we believe that the effects of hospital acquisitions on hospital quality continues to be an area that would benefit from additional research.

4. These extensions serve as checks on our baseline model. In the first extension, we modify our specification to control for time-invariant hospital characteristics using hospital fixed effects. In the second extension, we match each acquired hospital to the most similar non-acquired comparison hospital. The consistency of the results in our baseline and alternative specifications increases our confidence that we are identifying the effects of hospital acquisitions on costs and revenue rather than capturing the effects of confounding factors that might have differentially affected acquired and benchmark hospitals.

5. Our first study utilized a similar database covering the period 2009-2014.

6. The quantitative measures described throughout this study are calculated relative to group of benchmark hospitals. For example, a “3.3 percent reduction in operating expense per admission” means that operating expense per admission at the acquired hospitals increased 3.3 percent less than operating expense per admission at comparison hospitals. The statement does not, however, necessarily mean that operating expense per admission at the acquired hospitals went down in absolute terms.

7. In our previous study we found that an acquisition is associated with a statistically significant decrease of 3.5 percent in net patient revenue per adjusted admission. Our current results now indicate a statistically significant 3.7 percent decrease in net patient revenue per adjusted admission. As in both of our previous analyses, the revenue decline that we measure is not statistically significantly different than the expense decline.

In the next section, we briefly describe the cost, revenue, and quality measures that we analyze, as well as other data sources that we use. These measures are the same as those used in our previous analyses and are described in greater detail in our first report.

### III. DATA DESCRIPTION

#### A. HOSPITAL TRANSACTION DATA

We track hospital acquisitions by identifying changes in a hospital's affiliation as reported in the American Hospital Association (AHA) Annual Survey Data, as well as identifying changes in hospitals' affiliations noted in the accompanying documentation. For each hospital transaction identified using these AHA sources, we independently verify that the transaction closed and determine the date on which it closed.<sup>8</sup>

Using this method, we compile a list of acquisitions involving non-federal short-term acute care hospitals in the United States between 2009 and 2019.<sup>9</sup> As described in more detail below, we also collect data on all non-federal short-term acute care hospitals that were not acquired during this period to serve as a benchmark against which to measure changes in cost, revenue, and quality for the acquired hospitals included in our study. Many hospitals during this time period were involved in looser affiliations that fell short of full asset acquisitions. We do not exclude these hospitals from our set of benchmark hospitals against which we compared the acquired hospitals.<sup>10</sup>

#### B. COST AND REVENUE DATA

We use hospital cost and revenue data from the Centers for Medicare and Medicaid Services' (CMS) Healthcare Cost Report Information System (HCRIS). The HCRIS database contains annual financial reports that all hospitals participating in the Medicare program must file. We measure costs as expenses incurred during the ordinary course of operating the hospital, which include expenses associated with both inpatient and outpatient care. To control for differences in costs associated with the number of patients who received care at the hospital, we normalize these costs by dividing them by the number of adjusted admissions to the hospital.<sup>11</sup> During our interviews with hospital leaders, several indicated that they monitor this financial metric of cost per adjusted admission as part of their hospitals' operations, and the metric has also been used in other studies of the effect of hospital acquisitions on costs.<sup>12</sup>

We also examine the effect of hospital acquisitions on revenue, measured as net patient revenue per adjusted admission. This measure includes revenue associated with both inpatient and outpatient care and accounts for contractual allowances and other discounts agreed to by the hospitals. This measure includes reimbursement for care provided to traditional Medicare and Medicaid beneficiaries, which is set administratively, and for commercial, Medicare Advantage, and managed Medicaid plans, which is generally negotiated by hospitals

8. We take this additional step because some sources of information on hospital acquisitions used in previous research record when the transaction was announced, but not whether or when the transaction successfully closed. Inclusion of these non-consummated transactions in econometric analyses may result in biased estimates of the effects of hospital transactions.

9. We exclude critical access hospitals, which are small, geographically isolated hospitals.

10. To the extent these looser affiliations provide some of the same cost and quality benefits that acquisitions do, including these hospitals in the comparison group would tend to understate the benefits of acquisitions relative to hospitals that were not involved in any type of affiliation or acquisition.

11. Using data reported to the AHA in its Annual Survey, we calculate the number of adjusted admissions by taking the number of inpatient admissions and adding a number of "outpatient admissions" based on the relative magnitudes of inpatient and outpatient revenue reported at the hospital (i.e., outpatient revenue is converted to an equivalent number of inpatient admissions).

12. See, e.g., Connor, Robert A., Roger D. Feldman, and Bryan E. Dowd, "The Effects of Market Concentration and Horizontal Mergers on Hospital Costs and Prices," *International Journal of the Economics of Business* 5, no. 2 (1998): 159-180.; Spang, Heather Radach, Gloria J. Bazzoli, and Richard J. Arnould, "Hospital Mergers And Savings For Consumers: Exploring New Evidence," *Health Affairs* 20, no. 4 (2001): 150-158, doi: 10.1377/hlthaff.20.4.150. (Available at <http://content.healthaffairs.org/content/20/4/150.full>); Alexander, Jeffrey A., Michael T. Halpern, and Shouu-Yih D. Lee, "The Short-Term Effects of Merger on Hospital Operations," *Health Services Research* 30, no. 6 (1996): 827-847. (Available at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1070095/>.)

and health plans. This measure of hospital revenue is also used by hospitals in managing their operations and has been used in previous studies of hospital acquisitions.<sup>13</sup> While not solely a measure of prices negotiated by hospitals and health plans, we would expect revenue per adjusted admission to increase if negotiated commercial or Medicare Advantage prices increased following an acquisition. However, since changes in revenue per adjusted admission may also be affected by changes in payor mix or service mix, results involving this measure should be interpreted with care.

### **C. HOSPITAL QUALITY DATA**

We measure hospital quality using metrics published in the Hospital Compare database compiled by CMS. We focus on six outcome measures that were collected consistently by CMS from 2009 to 2019: three measures of 30-day readmission rates for acute myocardial infarction (or heart attack), heart failure, and pneumonia and three measures of 30-day mortality rates for heart attack, heart failure, and pneumonia. To reduce the variability in these measures of quality and improve the statistical power of our analyses, we combine the six separate outcome measures tracked by CMS into three outcome indices: one for mortality, one for readmission, and one that combines both mortality and readmission measures.<sup>14</sup>

### **D. DATA ON OTHER FACTORS AFFECTING COST, REVENUE, AND QUALITY**

We also account for other factors unrelated to acquisitions that may affect hospitals' cost, revenue, or quality. Briefly, we rely on the AHA Annual Survey to identify the ownership type (for-profit, not-for-profit, or public) and whether the hospital self-reported as being a rural hospital or was located in an area defined as rural by the Office of Management and Budget. We identify major teaching hospitals as those that belong to the Council of Teaching Hospitals.

We also account for differences in hospitals' payor mix and size based on the numbers of Medicare days, Medicaid days, and total inpatient admissions as recorded in the AHA Annual Survey. To account for service mix we use the percentage of gross revenue accounted for by outpatient services from the CMS HCRIS database. To account for differences in the cost of services provided by the hospitals, we use the hospital case mix index (CMI), which is a measure of the complexity and resources associated with inpatient services provided by the a hospital to Medicare beneficiaries, and the hospital wage index, which is used by CMS to adjust for geographic differences in the cost of employing hospital patient care staff. We obtain both measures from CMS.

Finally, we compare merging hospitals with nearby non-acquired hospitals based on each hospital's Hospital Referral Region (HRR), as defined by the Dartmouth Atlas.<sup>15</sup> HRRs are commonly used to group hospitals into relatively homogeneous geographic areas.

Overall, our analysis includes data for approximately 3,000 non-federal short-term acute care hospitals between 2009 and 2019. Among these hospitals, 755 were acquired during this time period. An observation in our statistical analyses corresponds to one hospital-year combination; in total, there are slightly more than 25,000 hospital-year observations in our analyses.<sup>16</sup>

13. See, e.g., Connor et al. (1998) and Radach et al. (2001).

14. To construct these composite indices, we normalize each component of the index by calculating the difference between each hospital's rate and the average rate of all hospitals, and then divide this difference by a measure of the dispersion of the rate. (In more technical terms, we transform each component to have a mean of zero and a standard deviation of one.) The composite outcome index is calculated as the simple average of these normalized components.

15. See The Dartmouth Atlas of Health Care *available* at <http://www.dartmouthatlas.org>.

16. For each observation we record whether, as of that year, the hospital had previously been acquired during the period of our study; the hospital's operating cost and net revenue per adjusted admission in that year; the hospital's readmission and mortality outcome measures for that year; and information on the hospital's payor mix, service mix, location, for-profit status, teaching status, and Medicare wage index in that year.

## IV. MEASURING THE EFFECTS OF HOSPITAL ACQUISITIONS

As in our previous studies, we use a “difference-in-differences” method to measure the effect of hospital acquisitions on cost, quality, and revenue. Using this approach, we compare changes in cost, revenue, and quality at acquired hospitals to changes in those same measures at similar control hospitals not involved in an acquisition between 2009 and 2019. In so doing, we assume that, absent the acquisition (after controlling for other factors included in our model), cost, revenue, and quality would have changed at the acquired hospitals in the same way that those measures changed at the benchmark non-acquired hospitals. In our analyses, we study the effect of the acquisition only on the target hospital of the deal, not on the acquiring hospital or hospital system. To the extent that the acquiring hospital or hospital system also benefits from the acquisition, our estimates would err on the side of finding no effect. We assume that any effect of the acquisition on the acquired hospital is realized in the first full year after the transaction was closed.<sup>17</sup>

As described above, our analyses include controls for factors other than the transaction that may have affected hospitals’ cost, revenue, or quality. Following the previous literature, we control for whether the hospital is for-profit, whether the hospital is a teaching hospital, and whether the hospital is located in a rural area. To control for geographic variation in hospitals’ labor costs, we include the Medicare wage index. Differences in the payor mix at hospitals are controlled for using the percentage of inpatient days accounted for by Medicare beneficiaries and the percentage of inpatient days accounted for by Medicaid beneficiaries. To account for differences in hospital size, we include the number of inpatient admissions at the hospital. Finally, to control for differences in hospitals’ service mix and the cost of services provided by the hospital, we include the fraction of the hospital’s revenue attributable to outpatient services and the logarithm of the hospital’s CMI.

In our analyses, changes in the merging hospital’s cost, revenue, or quality are measured relative to non-merging hospitals in the same Hospital Referral Region in the same year.<sup>18,19</sup> As mentioned above, we assume that any effect of the acquisition is realized in the first year following the closing of the transaction, and that the effect is constant during the post-acquisition period.

As mentioned previously, we extend our analyses with two alternative specifications based on literature published since our first report. These serve as robustness checks to our basic model. In the first alternative specification we exclude the time-invariant hospital specific variables and replace them with individual hospital fixed effects.<sup>20</sup> Working from this specification, we implement a second alternative based on a matched set of control hospitals. To do so, we first assign each acquired hospital to a single similar control hospital. We then estimate our regressions utilizing this reduced set of acquired and matched control hospitals.

## V. RESULTS AND DISCUSSION

### A. REVENUE AND COST FINDINGS

Consistent with our previous findings, we find that hospital acquisitions are associated with statistically significant decreases in both cost and revenue. Specifically, our updated estimates show that an acquisition is

17. To the extent that some benefits—such as improvements in mortality or readmissions indicators of quality—take longer to obtain (*i.e.*, the acquisition benefits are not fully realized in the first full year after the transaction), our results will be understated.

18. We measure revenue and cost in logarithms so that the estimated effects of hospital acquisitions are expressed in percentage terms rather than dollar terms (*e.g.*, a 3.3 percent reduction in costs per adjusted admission rather than a \$500 reduction in costs per adjusted admission).

19. In the current analyses, we account for intra-hospital correlation in the error terms in our model and cluster standard errors by hospital. For our cost and revenue regressions, we weight each observation by the number of associated adjusted discharges for the hospital in that year. Previous research has adopted a similar approach. (See Schmitt, Matt. “Do Hospital Mergers Reduce Costs?” *Journal of Health Economics* 52 (2017): 74-94, doi:10.1016/j.jhealeco.2017.01.007)

20. The variables replaced with hospital specific fixed effects are for-profit status, teaching status, and rural status. We exclude these variables from our fixed-effects specifications because they generally do not vary over time.

associated with a statistically significant decrease in operating expense per adjusted admission of 3.3 percent. (A complete set of results for cost and revenue are shown below in Table 1.) The average annual operating expenses of the acquired hospitals in our data was approximately \$292 million, indicating average acquisition-related savings of \$9.5 million per year at acquired hospitals. We also find that an acquisition is associated with a statistically significant decrease of 3.7 percent in net patient revenue per adjusted admission.<sup>21</sup> Applied to an average annual net patient revenue of \$292 million among acquired hospitals, this decrease in net patient revenue per adjusted admission translates to a reduction in expenditures of \$10.7 million per year. While not a direct measure of negotiated hospital prices, these results suggest that third-party payors appear to benefit from lower prices at acquired hospitals. Lastly, we note that average operating expense and net patient revenue are approximately equal at the acquired hospitals in our sample, suggesting that, on average, these acquired hospitals have an operating margin of zero dollars. This is consistent with our interviews of hospital leaders, who suggested that a primary motivation for hospital acquisitions is those hospitals' need for financial stability.

In addition to following the approaches we used in our prior studies, in this update we present two alternative methods for estimating the effects of hospital mergers that follow Schmitt (2017). In the first alternative, we include "fixed effects" for each hospital. These hospital fixed effects capture time-invariant hospital characteristics that may affect cost, revenue, or quality. In specifications that include hospital fixed effects, we exclude controls for whether the hospital was for profit, whether the hospital was a major teaching hospital, and whether the hospital was located in a rural area. In addition to controlling for these types of *observable* hospital characteristics that generally do not change over time, hospital fixed effects provide a way of accounting for *unobservable* hospital characteristics that do not change over time. Stated differently, the fixed effects specification flexibly controls for a large variety of time-invariant hospital characteristics, both observed and unobserved.

In the second alternative, we include hospital fixed effects and limit the group of non-acquired benchmark hospitals to only those hospitals that are most comparable to the acquired hospitals. As discussed earlier, we assume in our analyses that—absent the acquisitions—cost, revenue, and quality measures would change at the acquired hospitals in the same way these measures changed at the comparison hospitals. To test this assumption, we estimate our models using a different group of comparison hospitals that matches each acquired hospital to its most similar non-acquired benchmark hospital.<sup>22</sup> This method reduces the likelihood that our findings are affected by differences between the acquired and benchmark hospitals that are unrelated to the effects of the acquisition itself.

We find similar results for the effects of hospital acquisition on cost and revenue in both of our alternative specifications. As shown below in Table 2, our results with the inclusion of hospital fixed effects indicate that acquisition is associated with a statistically significant decrease in operating expense per adjusted admission of 2.3 percent. We also find that acquisition is associated with a statistically significant decrease of 2.2 percent in net patient revenue per adjusted admission. The table also shows the results of the hospital fixed effects specification utilizing matched benchmark hospitals. These results indicate that acquisition is associated with a statistically significant decrease in operating expense per adjusted admission of 2.4 percent and a statistically significant decrease of 1.8 percent in net patient revenue per adjusted admission. The consistency of the results in our baseline and alternative specifications increases our confidence that our estimates are identifying the effects of hospital acquisitions on costs and revenue rather than capturing the effect confounding factors that might have differentially affected acquired and benchmark hospitals.

21. Although these estimates suggest that acquisitions are associated with larger decreases in revenue, costs in our sample decline by a smaller percentage than does revenue. The precision of the estimates is such that the magnitudes of the reduction in costs and revenue are not statistically significantly different from each other.

## B. QUALITY FINDINGS

As with our 2019 study, our updated results show that acquisitions are associated with statistically significant improvements in quality measured as decreases in the overall outcome composite index (where a negative estimate indicates improved quality) and the 30-day readmission rate index. As is shown in Table 3 below, our updated results are somewhat attenuated in both magnitude and significance relative to our 2019 results. In particular, we no longer find a statistically significant decline in the mortality rates as a result of acquisitions, although the estimated magnitude of the decrease in mortality is similar to our previous estimates. However, because our composite outcome measure of quality—which includes both readmission and mortality rates—continues to reflect a statistically significant improvement in quality, our updated results continue to provide evidence that important indicators of quality of care improve at acquired hospitals post-acquisition.<sup>23</sup>

To provide an illustration of the magnitude of the effects, we find it helpful to calculate how large an effect our results imply if the reduction in readmission rates were due entirely to changes in the readmission rates for heart attacks (with no effect on readmission rates for either heart failure or pneumonia).<sup>24</sup> Under this scenario, our results predict a decrease of 1.1 percent in the 30-day readmission rate for heart attacks at acquired hospitals. Quality results in our two alternative specifications are somewhat mixed. Our hospital fixed effects model indicates a larger, more significant decrease in readmission rates, but we do not find a similar result using our set of matched benchmark hospitals (which includes a smaller number of hospitals).

The imprecision in our estimates of the effects of hospital acquisitions on quality are perhaps not surprising. Some of our estimates may not be statistically insignificant because hospital quality is inherently difficult to measure. As we explained in our previous study, quantitative measures of hospital quality are limited to specific conditions that must be risk-adjusted to account for differences in patients' comorbidities and severity of illness, which may be difficult without access to patients' detailed medical records in addition to the administrative data used by CMS to calculate the measures. Moreover, the addition of 144 recent hospital transactions to our analysis may make it difficult to detect quality improvements at acquired hospitals over the short post-acquisition time period reflected in our results.

## VI. CONCLUSION

During the two rounds of interviews summarized in our previous studies, hospital leaders described their hospitals' efforts to deliver higher quality care in a more cost-effective manner. Two frequently cited factors in achieving this goal were increased scale and the establishment of more standard processes of care, both of which are facilitated by acquisitions. With these factors in place, hospitals are better able to make the necessary infrastructure and information-technology investments that the modern healthcare system demands while also controlling costs, allowing for higher quality care at lower cost. Our updated econometric analyses continue to indicate that through hospital acquisitions, hospital systems have been successful in reducing costs, lowering expenditures, and improving quality.

22. Adopting a method similar to Schmitt (2017), we match hospitals using the Mahalanobis distance in terms of inpatient discharges, percent Medicare, percent Medicaid, percent outpatient revenue, wage index, CMI, and the outcome of interest. Hospitals are matched using the earliest pre-merger year of available data.

23. Our results for the effects of hospital acquisition on 30-day readmission and mortality rates in both of our alternative specifications are shown in Table 4. For specifications including hospital fixed effects, we continue to find statistically significant declines in the composite outcome measure and the 30-day readmission rate index for acquired hospitals. As in our primary specification, the decline in 30-day mortality rates for acquired hospitals is not statistically significant for our fixed-effect specification. In the alternative specifications with hospital fixed effects and matched control hospitals—which are estimated using substantially fewer observations—the effects of hospital acquisitions on all three outcome measures of quality are statistically insignificant.

24. A similar calculation would be possible under the assumption reduction in readmission rates were due entirely to changes in the readmission rates for heart failure with no effect on readmission rates for either heart attacks or pneumonia, or changes in the readmission rates for pneumonia with no effect on readmission rates for either heart attacks or heart failure.

**TABLE 1: OPERATING EXPENSE AND NET REVENUE PER ADJUSTED ADMISSION<sup>25</sup>**

Variables	log (Expense) 2021 Update (1)	log (Expense) 2019 Update (2)	log (Revenue) 2019 Update (3)	log (Revenue) 2019 Update (4)
Post-Acquisition	-0.0332*** (0.0119)	-0.0233*** (0.00710)	-0.0376*** (0.0121)	-0.0347*** (0.00735)
For Profit Hospital	-0.0532*** (0.0147)	-0.0163*** (0.00595)	0.0500*** (0.0147)	0.0738*** (0.00616)
Teaching Hospital	0.205*** (0.0173)	0.250*** (0.00781)	0.152*** (0.0181)	0.164*** (0.00809)
Rural Hospital	0.0180 (0.0119)	0.00737 (0.00589)	0.00789 (0.0122)	-0.0137** (0.00610)
log: Wage Index	0.280*** (0.0721)	0.403*** (0.0392)	0.333*** (0.0713)	0.527*** (0.0406)
log: % Medicare Days	-0.102*** (0.0166)	-0.121*** (0.00543)	0.00324 (0.0350)	-0.111*** (0.00562)
log: % Medicaid Days	0.0152 (0.00959)	-0.00171 (0.00334)	-0.0138 (0.0100)	-0.0259*** (0.00345)
log: IP Admissions	0.00250 (0.00881)	-0.0384*** (0.00328)	0.0161 (0.0100)	-0.0172*** (0.00340)
log: % OP Revenue	-0.0847*** (0.0309)	-0.200*** (0.0103)	-0.127*** (0.0351)	-0.196*** (0.0107)
log: CMI	1.242*** (0.0541)	1.035*** (0.0164)	1.310*** (0.0513)	1.147*** (0.0169)
Constant	8.483*** (0.0746)	8.816*** (0.0292)	8.323*** (0.0900)	8.568*** (0.0302)
Observations	25,153	19,883	25,147	19,879
R-squared	0.709	0.632	0.680	0.642
HRR Code FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Clustered Standard Errors	Yes	No	Yes	No
Weighted	Yes	No	Yes	No

25. Notes. Standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0. The dependent variables in columns (1) and (2) are the logarithm of operating expenses per adjusted admission; the dependent variables in columns (3) and (4) are the logarithm of net revenue per adjusted admission. Columns (2) and (4) are reproduced from our 2019 update to our study of hospital acquisitions and are included for comparison. Controls for each regression—including whether the regressions include HRR and year fixed effects—are indicated in the rows of the table. Regressions in columns (1) and (3) are weighted by the number of adjusted admissions for each hospital in each year. Standard errors for the regressions in columns (1) and (3) are clustered by hospital. Observations in the regressions correspond to hospital-years. The regressions in columns (1) and (3) include observations for approximately 3,000 non-federal short-term acute care hospitals between 2009 and 2019. The regressions in columns (2) and (4) include observations for these hospitals between 2009 and 2017.



**TABLE 2: ALTERNATIVE SPECIFICATIONS FOR OPERATING EXPENSE AND NET REVENUE PER ADJUSTED ADMISSION<sup>26</sup>**

Variables	log (Expense) (1)	log (Expense) (2)	log (Revenue) (3)	log (Revenue) (4)
Post-Acquisition	-0.0235*** (0.00534)	-0.0238*** (0.00554)	-0.0226*** (0.00577)	-0.0186*** (0.00611)
log: Wage Index	0.350*** (0.0318)	0.275*** (0.0394)	0.459*** (0.0354)	0.399*** (0.0430)
log: % Medicare Days	0.0282*** (0.00992)	0.0422*** (0.0119)	0.0310*** (0.0106)	0.0451*** (0.0125)
log: % Medicaid Days	0.0184*** (0.00526)	0.00724 (0.00612)	0.0190*** (0.00544)	0.00172 (0.00618)
log: IP Admissions	-0.348*** (0.0159)	-0.377*** (0.0229)	-0.265*** (0.0171)	-0.276*** (0.0246)
log: % OP Revenue	-0.164*** (0.0244)	-0.139*** (0.0253)	-0.164*** (0.0332)	-0.110*** (0.0259)
log: CMI	0.241*** (0.0271)	0.208*** (0.0352)	0.251*** (0.0295)	0.278*** (0.0389)
Constant	12.03*** (0.141)	12.29*** (0.203)	11.30*** (0.150)	11.38*** (0.218)
Observations	25,153	14,178	25,147	14,094
R-squared	0.895	0.879	0.879	0.861
Hospital FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Matched Controls	No	Yes	No	Yes

26. Notes. Standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0. The dependent variables in columns (1) and (2) are the logarithm of operating expenses per adjusted admission; the dependent variables in columns (3) and (4) are the logarithm of net revenue per adjusted admission. Controls for each regression are indicated in the rows of the table; each regression also includes both hospital and year fixed effects. Controls for hospital characteristics that are largely time invariant (i.e., for-profit status, teaching status, and whether the hospital was in a rural area) are omitted. Observations in the regressions correspond to hospital-year combinations between 2009 and 2019. In columns (2) and (4) we match each acquired hospital in the sample to its most similar non-acquired hospital to serve as a control. We match hospitals using the Mahalanobis distance in terms of inpatient discharges, percent Medicare, percent Medicaid, percent outpatient revenue, wage index, CMI, and the outcome of interest. Hospitals are matched using the earliest pre-acquisition year of available data. All hospital-year observations for both the acquired hospitals and the matched control hospitals are included in the regressions.

**TABLE 3: 30-DAY READMISSION AND MORTALITY RATES<sup>27</sup>**

Variables	Outcome Composite 2021 Update (1)	Outcome Composite 2019 Update (2)	Readmission Composite 2021 Update (3)	Readmission Composite 2019 Update (4)	Mortality Composite 2021 Update (5)	Mortality Composite 2019 Update (6)
Post-Acquisition	-0.0307** (0.0128)	-0.0332*** (0.00971)	-0.0332** (0.0169)	-0.0383*** (0.0133)	-0.0283 (0.0192)	-0.0281** (0.0140)
For Profit Hospital	0.114*** (0.0141)	0.112*** (0.00813)	0.168*** (0.0186)	0.162*** (0.0111)	0.0603*** (0.0216)	0.0622*** (0.0117)
Teaching Hospital	0.0396* (0.0206)	0.0556*** (0.0107)	0.249*** (0.0285)	0.264*** (0.0146)	-0.169*** (0.0301)	-0.153** (0.0154)*
Rural Hospital	-0.00390 (0.0131)	-0.00234 (0.00805)	0.00997 (0.0183)	0.00721 (0.0110)	-0.0178 (0.0206)	-0.0119 (0.0116)
log: Wage Index	-0.256*** (0.0824)	-0.267*** (0.0536)	-0.108 (0.120)	-0.163** (0.0735)	-0.404*** (0.122)	-0.370*** (0.0772)
log: % Medicare Days	0.0136 (0.0146)	0.0142* (0.00742)	0.0190 (0.0200)	0.0169* (0.0102)	0.00826 (0.0162)	0.0114 (0.0107)
log: % Medicaid Days	0.0582*** (0.00743)	0.0611*** (0.00456)	0.0479*** (0.00979)	0.0481*** (0.00626)	0.0685*** (0.0104)	0.0742*** (0.00656)
log: IP Admissions	-0.0130* (0.00768)	-0.0168*** (0.00449)	-0.00441 (0.0113)	-0.0120* (0.00615)	-0.0215** (0.0109)	-0.0215** (0.00646)*
log: % OP Revenue	-0.0499** (0.0252)	-0.0572*** (0.0141)	-0.218*** (0.0354)	-0.242*** (0.0193)	0.118*** (0.0355)	0.128*** (0.0203)
log: CMI	-0.397*** (0.0377)	-0.421*** (0.0224)	-0.692*** (0.0564)	-0.712*** (0.0307)	-0.101** (0.0511)	-0.130*** (0.0322)
Constant	0.558*** (0.0643)	0.535*** (0.0399)	0.710*** (0.0915)	0.639*** (0.0548)	0.407*** (0.0940)	0.432*** (0.0575)
Observations	25,157	19,886	25,157	19,886	25,157	19,886
R-squared	0.454	0.432	0.627	0.608	0.344	0.365
HRR Code FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered	Yes	No	Yes	No	Yes	No
Weighted	No	No	No	No	No	No

27. Notes. Standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0. The dependent variables in columns (1) and (2) are composite measures of 30-day readmission rates and 30-day mortality rates for heart attack, heart failure, and pneumonia; the dependent variables in columns (3) and (4) are composite measures of 30-day readmission rates for these three conditions; and the dependent variables in columns (5) and (6) are composite measures of 30-day mortality rates for these three conditions. Columns (2), (4), and (6) are reproduced from our 2019 update to our study of hospital acquisitions and are included for comparison. Controls for each regression—including whether the regressions include HRR and year fixed effects—are indicated in the rows of the table. Standard errors for the regressions in columns (1), (3), and (5) are clustered by hospital. Observations in the regressions correspond to hospital-years. The regressions in columns (1), (3), and (5) include observations for approximately 3,000 non-federal short-term acute care hospitals between 2009 and 2019. The regressions in columns (2), (4), and (6) include observations for these hospitals between 2009 and 2017.

**TABLE 4: ALTERNATIVE SPECIFICATIONS FOR 30-DAY READMISSION AND MORTALITY RATES<sup>28</sup>**

Variables	Outcome Composite (1)	Outcome Composite (2)	Readmission Composite (3)	Readmission Composite (4)	Mortality Composite (5)	Mortality Composite (6)
Post-Acquisition	-0.0281*** (0.00881)	-0.00865 (0.00996)	-0.0420*** (0.0122)	0.00814 (0.0138)	-0.0142 (0.0122)	-0.0142 (0.0135)
log: Wage Index	-0.170*** (0.0556)	-0.0813 (0.0788)	-0.0738 (0.0777)	0.0728 (0.111)	-0.267*** (0.0772)	-0.219** (0.107)
log: % Medicare Days	-0.0177** (0.00841)	-0.0408** (0.0173)	-0.0107 (0.0122)	0.0152 (0.0240)	-0.0248** (0.0112)	-0.0280* (0.0166)
log: % Medicaid Days	-0.0418*** (0.00542)	-0.0631*** (0.00912)	-0.0585*** (0.00784)	-0.0773*** (0.0134)	-0.0252*** (0.00709)	-0.0227* (0.0117)
log: IP Admissions	-0.0299** (0.0125)	-0.00737 (0.0192)	0.110*** (0.0179)	0.246*** (0.0286)	-0.170*** (0.0167)	-0.161*** (0.0262)
log: % OP Revenue	-0.0822*** (0.0223)	-0.0855*** (0.0273)	-0.159*** (0.0385)	-0.123** (0.0500)	-0.00572 (0.0246)	0.0159 (0.0321)
log: CMI	-0.568*** (0.0387)	-1.013*** (0.0568)	-0.673*** (0.0554)	-1.081*** (0.0825)	-0.464*** (0.0481)	-0.834*** (0.0757)
Constant	0.549*** (0.112)	0.515*** (0.178)	-0.435*** (0.157)	-1.443*** (0.257)	1.534*** (0.151)	1.624** (0.239)*
Observations	25,157	12,332	25,157	12,375	25,157	13,024
R-squared	0.721	0.734	0.809	0.830	0.694	0.688
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Matched Controls	No	Yes	No	Yes	No	Yes

28. Notes. Standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0. The dependent variables in columns (1) and (2) are composite measures of 30-day readmission rates and 30-day mortality rates for heart attack, heart failure, and pneumonia; the dependent variables in columns (3) and (4) are composite measures of 30-day readmission rates for these three conditions; and the dependent variables in columns (5) and (6) are composite measures of 30-day mortality rates for these three conditions. Controls for each regression are indicated in the rows of the table; each regression also includes both hospital and year fixed effects. Controls for hospital characteristics that are largely time invariant (*i.e.*, for-profit status, teaching status, and whether the hospital was in a rural area) are omitted. Observations in the regressions correspond to hospital-year combinations between 2009 and 2019. In columns (2), (4), and (6) we match each acquired hospital in the sample to its most similar non-acquired hospital to serve as a control. We match hospitals using the Mahalanobis distance in terms of inpatient discharges, percent Medicare, percent Medicaid, percent outpatient revenue, wage index, CMI, and the outcome of interest. Hospitals are matched using the earliest pre-acquisition year of available data. All hospital-year observations for both the acquired hospitals and the matched control hospitals are included in the regressions.