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Determining the Effects of Hospital Consolidation: An Examination of the Impact of Hospital M&A on Financial and Quality Metrics

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DETERMINING THE EFFECTS OF HOSPITAL CONSOLIDATION: AN EXAMINATION OF THE IMPACT OF HOSPITAL M&A ON FINANCIAL AND QUALITY METRICS

by

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ABSTRACT

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The modern explosion of M&A activity in the United States has generated significant controversy and advocates both for and against hospital consolidation have been quite vocal in presenting their cases. Using mergers and acquisitions reports from Irving Levin Associates as well as financial and quality metrics from the Centers for Medicare and Medicaid Services and the American Hospital Directory, this study examines the differences between consolidated and unconsolidated hospitals in terms of overall revenue and quality, in addition to prices and costs for specified diagnoses. Consolidated hospitals undergo significant changes during their transition and often times operate in a manner different than that of an unconsolidated hospital, suggesting that these figures will be different on a comparison basis.

To asses the differences between consolidated and unconsolidated hospitals, this paper uses Ordinary Least Squares regressions and three propensity score matching methods: nearest neighbor, kernel, and stratification matching. These matching methods are used to mitigate for the potential endogeneity associated with hospital M&A analysis.

This study finds that hospitals which underwent M&A between 2012 and 2014 have higher revenues but lower quality, while they charge lower prices and cost less to payers for several of the presented diagnoses. To make hospital mergers and acquisitions

truly efficient, consolidated hospitals should strive to increase quality while continuing to operate in a financially efficient manner.

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CHAPTER ONE

INTRODUCTION

A. Hospital Mergers and Acquisitions

Since 2010, the United States has seen a boom in the number of hospital mergers and acquisitions, following a historical pattern of large amounts of hospital consolidations occurring over a time period of several years. Looking at the year 2016, 102 planned mergers and acquisitions were announced throughout the year, a 55% increase over the year 2010 (Kaufman Hall & Associates, 2017). Due to the critical and pervasive nature of the services which are provided by hospitals, changes within the hospital market can have impacts on the entire U.S. population, both in terms of the the quality of care delivered and the costs for the care. While the quality of care is most directly felt by patients and their families, changes in the costs for care are mainly absorbed by medical insurance providers, both public and private.

The modern healthcare era has presented a time where hospitals have struggled to remain financially stable as a result of increased quality requisites and inconsistent reimbursements from insurers. The threats that these hospitals face are real, 21 U.S. hospitals shuttered in 2016 alone, many in rural communities which now have no easy access to critical care (Ellison, 2017). Additionally, insurers both public and private are seeking to curtail growing healthcare costs by linking payment values to quality and efficiency of care, forcing hospitals to rethink their current models of care while facing declining reimbursements (MacDonald, 2017). Many hospitals have turned to mergers and acquisitions as a way to cut costs and remain afloat in the cutthroat healthcare

market. Although M&A is often perceived by hospitals as a means to survival, hospital consolidation is frequently met with arguments that hospitals use M&A as a way to obtain more money from insurance providers while simultaneously providing lower quality of care (Sutaria, 2013). As there are two sides to this hospital M&A story, the conflicting arguments make it difficult to ascertain the real effects of hospital consolidation.

Previous studies have examined the effects of hospital mergers and acquisitions on price, cost, quality, and revenues. As exemplified by the current flurry of M&A activity, hospital mergers and acquisitions tend to occur in waves, with the last explosion of mergers and acquisitions occurring in the 1990s. The year 2010 marked the beginning of a new wave which has not yet shown signs of slowing (Creswell and Abelson, 2013). Several research studies have been conducted on the effects of the mergers of the 1990s, while scholarly work is just now starting to examine the more recent wave. In the developing body of present-day studies, Schmitt (2017) looks at operations cost differences between hospitals as a result of consolidation for the years 1998 to 2012, while Su (2017) examines Medicare cost and quality changes as a result of hospital consolidation occurring between 2011 and 2013. When looking at hospital mergers and acquisitions, it is important to consider both financial and quality dimensions as Su (2017) does. The industry is an essential one which impacts the lives of the overwhelming majority of Americans in terms of both financial costs and physical wellbeing. This study is the first to examine price, cost, and quality effects of hospital

mergers and acquisitions for the hospitals which underwent M&A in between 2012 and 2014, effectively encompassing both financial and quality analysis.

B. Contributions and Organization of this Study

In an effort to ascertain some of the potential outcomes of hospital mergers and acquisitions, this study uses price, cost, and quality panel data from the Centers for Medicare and Medicaid Services (CMS), M&A data from Irving Levin & Associates, and hospital size and financial data from the American Hospital Directory. Additional sources provided supplemental data to these key sets. Through comparing consolidated hospitals and unconsolidated hospitals with similar bed sizes and state of operation, while controlling for year effects and hospital type, this study finds that hospitals which have undergone M&A have higher revenues, but lower quality. Consolidated hospitals also post lower prices and costs for many of the diagnoses evaluated. These results suggest that while consolidated hospitals may be delivering more financially efficient care, they should direct additional attention to increasing the quality of care delivered in order to deliver care that is efficient in terms of both cost and quality.

This thesis proceeds to explain the analysis of the implications of hospital mergers and acquisitions on the revenues, quality, and costs and prices for hospital services. Chapter 2 provides a formalized review of the outstanding literature on hospital M&A. Chapter 3 continues to explain the economic model applied in this analysis and the estimation methods used to arrive at the results, while Chapter 4 discusses the data incorporated, the construction of the sample, and pertinent limitations. The empirical

results are reviewed in Chapter 5, with relevant tables included at the end of the paper. These results are extended to include implications and suggestions for future research in the conclusion section found in Chapter 6.

CHAPTER TWO

A REVIEW OF THE IMPACTS OF HOSPITAL MERGERS AND ACQUISITIONS

This literature review examines existing studies of hospital mergers and acquisitions. Specifically, this literature review analyzes work prompted by upticks in hospital consolidation, paying particular attention to the characteristics of merging hospitals and their markets, motivations for mergers and acquisitions, arguments against consolidation, outcomes of consolidations with regards to cost, and outcomes with regards to price.

A. Characteristics of Merging Hospitals and Markets

Due to the necessary services hospitals provide, hospitals exist in a wide variety of markets and are not always characterized by the same traits. In studies of hospital consolidations which consider impacts, economists have paid particular attention to hospital ownership differences, as well as the differences in the hospital market demographics. By recognizing that hospitals may change ownership type through consolidations, Sloan, Ostermann, and Conover (2003) consider what may prompt an ownership transition and conclude that hospitals are most likely to convert ownership because of a low profit margin. A conversion from nonprofit or government ownership to for profit status is most often preceded by consistently low margins and high debt-to-asset ratios, while hospitals transition from for-profit to nonprofit soon after experiencing declines in margins. The authors also note that many mergers are motivated not only by low profit margins, but also by an ability and desire to increase market power. Further

exploring hospital ownership type, Connor et al. (1997) focus on the characteristics of hospital markets which see high volumes of hospital M&A. The researchers examine market structure in defined health service areas to reason that hospitals merge most often in areas with less market concentration, higher penetration of healthcare maintenance organizations (HMOs), and in areas that are defined by fewer rural characteristics. When looking at the characteristics of hospitals undergoing M&A, Connor et al. (1997) find that hospitals engaging in mergers are less likely to be government owned, more likely to be a member of a system, are larger in terms of beds and admission, and have higher occupancy rates and case-mix indexes.

While Connor et al. (1997) and Sloan, Ostermann, and Conover (2003) endeavor to determine important pre-merger conditions, in their study, Melnick, Keeler, and Zwanziger (1999) compare nonprofit hospitals to for-profit hospitals to examine their behavior after the completion of a merger. The study concludes that hospital mergers which reduce competition in a market lead to both the merging hospitals and their competitors raising their prices, hospital ownership status did not matter. The study also acknowledges that nonprofit and government hospitals have increasingly become less adverse to exploiting their market power through raising prices.

After identifying that only in-market mergers had been studied at length, Dafny, Ho, and Lee (2016) test out of market merger consequences. The study concludes that mergers and acquisitions which occur between hospitals which are not in the same hospital referral region (HHR) generate a meaningful difference in price post-merger only when the merging hospitals are located in the same state.

Making additional contributions about hospital characteristics, Sloan (2001) looks at the non-profit dominated hospital market to ascertain some of the differences between non-profit and for-profit hospitals. The study finds that in terms of quality, hospital ownership status did not make a difference, but for-profit hospitals were more expensive to Medicare (Sloan, 2001).

Dafny (2009) notes in her study of hospital merger effects that hospital mergers do not occur randomly and therefore, examining mergers and acquisitions with certain estimation methods creates a problem of endogeneity. Her study corrects for this problem by looking at the price increases of rival hospitals after a merger of nearby independent hospitals, creating an interesting perspective on the market-wide impacts of hospital mergers (Dafny, 2009).

B. Motivations for Mergers and Acquisitions

Defining some of the reasons which motivate hospitals to undergo costly and strenuous mergers and acquisitions can help to better explain why between 1998 and 2012, the U.S. hospital market of approximately 5,000 acute care hospitals underwent 1,133 mergers and acquisitions (Novak, 2017). Cooper et al. (2015) looks at the characteristics which are most prevalent in hospitals with desirable financial outcomes. Hospitals may engage in M&A in order to obtain some of these characteristics. Their study finds that being for profit, having more medical technologies, being located in an area with high labor costs, behind a bigger hospital, being located in an area with lower

income, and having a low share of Medicare patients are all market factors which are associated with the ability to generate higher prices.

In their study of the modern landscape of hospital mergers and acquisitions, Brown et al. (2012) identify that the Affordable Care Act (ACA), through enhancing attention to quality and scrutinizing payments, may be driving consolidation in a few ways. Under the ACA, payments to many hospitals will decrease as a result of the new payment structures, therefore hospitals must find new ways to reduce or share costs and strengthen negotiating ability with suppliers and insurers. The act also mandates additional spending on compliance and technologies such as electronic health records (EHR), areas where mergers and acquisitions may help hospitals achieve economies of scale. Brown et al. (2012) argue that the ACA is driving hospitals to merge by rewarding the hospitals which can leverage consolidation to lower their costs and improve quality.

Using pre - ACA data, Dranove and Shanley (1995) examine cost and reputation as motivations for mergers and acquisitions and conclude that although costs are not different between local hospital systems, there are reputation benefits associated with creating a hospital system. Local hospital systems are able to develop a "brand identity" which helps them to market a message of uniform quality across their system which in turn draws in patients, creating a merger incentive.

C. Arguments against Consolidation

A common feature of the literature on hospital mergers and acquisitions is a debate of the potential impacts of consolidation on the price and quality of care delivered.

In reviewing the impacts of hospital consolidation, some economists have explicitly come out against M&A activity as they fear that the pitfalls of M&A outweigh the benefits (Xu, Wu, and Makary, 2015). Anti-consolidation advocates contend that there are other ways to achieve these goals which do not impact the structure or competition of hospital markets in a manner which leads to hospitals obtaining advantages not present with healthy competition (Ramirez, 2014; Tsai and Jha, 2014). On their part, hospitals argue that consolidation facilitates quality improvements and cost containment (Noether and May, 2017).

D. Outcomes of Consolidation - Cost

As noted in Brown et al. (2012) and Dranove and Shanley (1995), a major motivation for hospital consolidation is cost containment. The body of literature suggests that cost savings are realized by hospitals after mergers (Connor et al. 1997; Lynk, 1995; Schmitt, 2017). Specifically, Schmitt (2017) finds in his recent study that acquired hospitals realize cost savings between four percent and seven percent in the years immediately after acquisition. As there are different types of consolidation, Dranove and Lindrooth (2003) look at differences between system-to-system mergers versus one-to-one hospital mergers and find mixed results: system-to-system mergers yield no significant cost savings while one-to-one hospital mergers realize cost savings of about 14%, further contributing that hospital and market characteristics are important when evaluating impact. All above mentioned costs are operational costs incurred by hospitals, in terms of labor and supplies that the hospitals must use in order to treat patients, with

these results suggesting that hospitals that undergo M&A achieve greater economics of scale and use the achievement to reduce their operational costs.

In her thesis, Su (2017) addresses changes in costs pre and post-merger for specific diagnoses while defining cost in a different way. Su (2017) defines cost as the amount Medicare pays to a hospital for a patient with a specific diagnosis. Her study finds that there are no significant differences in costs to Medicare pre and post-merger for the diagnoses covered in her study, but also concludes that while using mortality rates as a proxy for quality, certain diagnoses have mortality rates which are higher in consolidated hospitals.

E. Outcomes of Consolidation - Price

While considering the impact of hospital mergers and acquisitions on price, there is considerable attention paid to price effects of mergers because if hospitals use M&A strengthen their bargaining ability, this may allow them to charge higher prices and subsequently receive higher reimbursements from insurers. The literature reviewed here indicates that hospital mergers decrease competition in the market and allow hospitals to significantly raise prices by asserting their new market power (Dafny, 2009; Dranove and Shanley, 1995; Krishnan and Krishnan, 2003; Xu, Wu, and Makary, 2015). Estimates for price increases range anywhere from nine percent to forty-five percent (Dauda, 2017; Xu, Wu, and Makary, 2015). However, some of the literature suggests increased concentration in the hospital market does not have a significant impact on price post - mergers (Moriya, Vogt, and Gaynor, 2010).

Although some of the available literature concluded that defining hospitals by ownership type will not greatly impact the results on cost or prices after a merger or acquisition because their behaviors may in fact be similar, this study controls for ownership type and incorporates the bed size, state of operation, and year of consolidation because they are hospital characteristics which could further impact price and cost (Melnick, Keeler, and Zwangizer, 1999; Sloan, 2001). Using the same "cost" definition as Su (2017), this study furthers the work on the impacts of mergers and acquisitions on costs, examining more diagnoses than Su (2017), and also continuing the work on quality done by the paper. This examination also corrects for the endogeneity bias identified by Dafny (2009), something not done by Su (2017). To summarize, this thesis contributes a study to the scholarly body on the revenue, quality, price, and cost impacts of hospital mergers and acquisitions.

CHAPTER THREE

ECONOMETRIC MODEL AND STATISTICAL METHODOLOGY

This chapter contains both the econometric model and statistical methodology used in this study. A description and discussion of the dependent and independent variables is also included.

A. Econometric Model used to Estimate the Effects of Hospital Mergers and Acquisitions

To determine how hospital mergers and acquisitions impact the dependent hospital revenue, quality, cost, and price variables included in this study, this examination employs the following econometric model:

$$Hospital\ Outcome = \beta_0 + \beta_1 Treatment + \beta_2 Beds + \beta_3 HospitalType + \beta_4 Year + \beta_5 State + \varepsilon,$$

with ε as the error term.

Dependent Variables

GrossPatientRevenue	The total amount of revenue generated for patient services.
TotalPerformanceScore	The total score received out of 100 on the CMS Hospital Value Based Purchasing Program assessment.
MedicarePayments039	Average Medicare cost for patients with DRG 039: Extracranial Procedures without Complications or Major Complications or Comorbidities.

AverageTotalPayments039	Average total cost for patients with DRG 039: Extracranial Procedures without Complications or Major Complications or Comorbidities.
AverageCoveredCharges039	Average total price for patients with DRG 039: Extracranial Procedures without Complications or Major Complications or Comorbidities.
MedicarePayments190	Average Medicare cost for patients with DRG 190: Chronic Obstructive Pulmonary Disorder with Major Complications or Comorbidities.
AverageTotalPayments190	Average total cost for patients with DRG 190: Chronic Obstructive Pulmonary Disorder with Major Complications or Comorbidities.
AverageCoveredCharges190	Average price for patients with DRG 190: Chronic Obstructive Pulmonary Disorder with Major Complications or Comorbidities.
MedicarePayments193	Average Medicare cost for patients with DRG 193: Simple Pneumonia & Pleurisy with Major Complications or Comorbidities.
AverageTotalPayments193	Average total cost for patients with DRG 193: Simple Pneumonia & Pleurisy with Major Complications or Comorbidities.
AverageCoveredCharges193	Average price for patients with DRG 193: Simple Pneumonia & Pleurisy with Major Complications or Comorbidities.
MedicarePayments282	Average Medicare cost for patients with DRG 282: Acute Myocardial Infarction, Discharged Alive without Complications or Major Complications or Comorbidities.
AverageTotalPayments282	Average total cost for patients with DRG 282: Acute Myocardial Infarction, Discharged Alive without Complications or Major Complications or Comorbidities.
AverageCoveredCharges282	Average price for patients with DRG 282: Acute Myocardial Infarction, Discharged Alive without Complications or Major Complications or Comorbidities.
MedicarePayments291	Average Medicare cost for patients with DRG 291: Heart Failure & Shock with Major Complications or Comorbidities.

AverageTotalPayments291	Average total cost for patients with DRG 291: Heart Failure & Shock with Major Complications or Comorbidities.
AverageCoveredCharges291	Average total price for patients with DRG 291: Heart Failure & Shock with Major Complications or Comorbidities.

Note: GrossPatientRevenue definition comes from the American Hospital Directory, while all other definitions come from cms.gov.

Independent Variables

Treatment	1 if the hospital underwent a merger of acquisition between 2012 and 2014; 0 if not
Beds	The number of staffed beds available
HospitalType	A group of dummy variables which are equal to 1 when the type matches the specified hospital type; 0 if not. Types are broken down between Government, Voluntary Nonprofit, and Proprietary with further subcategories.
Year	A group of dummy variables which are equal to 1 when the year matches the specified data year; 0 if not. Years range from 2011 to 2015.
State	A group of dummy variables which are equal to 1 when the state matches the specified hospital state; 0 if not. 18 states are included in this analysis.

The dependent variables are divided between overall hospital variables and diagnosis related variables. The dependent variable *GrossPatientRevenue* is an overall variable equal to the revenue earned by hospitals in the year 2017 in constant 2015 dollars. The second overall hospital variable, *TotalPerformanceScore*, is used as a measurement of hospital quality. The variable encompasses scores given by the Centers for Medicare and Medicaid Services (CMS) for mortality, experience of care, safety, efficiency, and cost reduction. This study includes this variable as a means of comparing

unconsolidated and consolidated hospitals on a basis of quality of care delivered, as the quality of care delivered should be the among the most important considerations, but also because CMS has begun to link reimbursements to the quality of care delivered. The inclusion of this variable helps to estimate whether or not consolidated hospitals will be able to maintain their level of reimbursements or if they should expect to see declines in reimbursements as compared to their unconsolidated peers as a result of their quality scores.

The next group of dependent variables are diagnosis specific and pertain to the prices and costs for the five diagnoses selected for analysis in this study. All five diagnoses, DRGs 039, 190, 193, 282, and 291 were chosen from the 100 most common Medicare covered diagnoses. The diagnoses were selected from this group in the hopes that their common occurrence would allow for them to have sufficient data for many of the merged and unmerged hospitals in the analysis. It is important to note that the diagnoses are only inclusive of the population which Medicare provides insurance for, typically U.S. citizens over the age of 65, and therefore these diagnoses may not be among the most frequent across the entire U.S. population. The prefixes for the study diagnosis variables, *MedicarePayments, AverageTotalPayments,* and *AverageCoveredCharges* denote whether or not the variable is a price or cost for the diagnosis. The *MedicarePayments* prefix refers to the average cost to Medicare for a patient diagnosed in that hospital with that particular condition after Medicare applies algorithms to determine payment amount and the hospitals respond with negotiations relating to advanced costs for particular patients related to severity, complications, and

comorbidities. *AverageTotalPayments* is similar to the *MedicarePayments* prefix, but refers to the average amount that supplemental insurance and patients pay to cover the remainder of charges for the diagnosis. This number is also subject to negotiations between insurances and the hospitals. If one were to add *MedicarePayments* and *AverageTotalPayments* for a diagnosis, they would arrive at the total cost to all payers for the diagnosis. Finally, the prefix *AverageCoveredCharges* describes the average sticker prices charged by hospitals for the five diagnoses included in this examination. *AverageCoveredCharges* are the contributing values to *GrossPatientRevenue,* representative of the amounts hospitals would receive if they were not subject to reductions from Medicare or other insurers.

Based upon the factors identified by Brown et al. (2012) as motivations for mergers and acquisitions, the expectation is that *GrossPatientRevenue* will increase as a result of consolidation. Brown et al. (2012) indicate in their review of modern motivations for hospital M&A that hospitals engage in consolidations in order to strengthen bargaining power with insurers. This suggests that hospitals will use this heightened ability to charge a higher sticker price to insurers based upon their ability to obtain more in payments. There is an expectation that quality will be lower in hospitals which underwent a merger or acquisition as proponents of increased scrutiny for hospital mergers and acquisitions often argue that consolidated hospitals provide patients with lower quality care (Ramirez, 2014; Tsai and Jha, 2014). In her examination of hospital M&A which uses mortality as a proxy for quality, Su (2017) finds that mortality rates increased in hospitals which underwent M&A between the years of 2011 and 2014,

suggesting that lower quality of care is being delivered in consolidated hospitals. The diagnosis variables of *MedicarePayments, AverageTotalPayments,* and *AverageCoveredCharges* are also expected to have positive coefficients. Following the thinking of Brown et al. (2012) presented above, *GrossPatientRevenue* is a summation of all the diagnosis values for *AverageCoveredCharges*, therefore the increased bargaining power should increase the individual diagnosis prices as well. The ability of hospitals to exact more from insurers and other payers should increase the two cost variables, *MedicarePayments* and *AverageTotalPayments*, because the larger hospitals will use their strengthened negotiating clout to garner more in return for their services from insurers, effectively costing both Medicare and non-Medicare payers more.

The independent variables were selected because of their potential impacts on the outcome variables for hospitals. The key independent variable, *Treatment*, divides hospitals on the basis of whether or not they underwent a merger and acquisition between the years of 2012 and 2014. This variable creates the primary comparison groups for this study before additional specifications are applied. The next independent variable assessed was *Beds,* which is equivalent to the number of staffed beds in a hospital via the Irving Levin and Associates reports for merged hospitals and from the American Hospital Directory for unmerged hospitals. Current research suggests that hospitals with greater numbers of staffed beds may deliver lower quality of care while costing more to insurance and Medicare, particularly in the case of highly regarded and highly expensive academic medical centers (Ibrahim, 2016). *Beds* is used as a contributing value to the

propensity score matching methods which will be discussed in the statistical methodology.

As business entities, hospitals are not all the same, therefore the independent variable *HospitalType* controls for the differences in hospitals which come from the ownership types. This study incorporates hospitals which file their taxes as Government, Voluntary Nonprofit, and Proprietary organizations. The majority of U.S. hospitals file as Voluntary Nonprofit, with approximately 50% of U.S. hospitals specified as nonprofit in 2016 (American Hospital Directory, 2018). Government organizations are further separated by State, Local, Federal, and Hospital District, while Voluntary Nonprofit has Church, Private, and Other specifications. Government and Voluntary Nonprofit hospitals behave in a manner which does not seek profits, but still strive to maintain their financial viability while Proprietary hospitals seek to maximize profits and return to stakeholders, potentially creating differences in the way these hospitals deliver services. The independent *Year* variable holds constant the fluctuations which pertain to the years included in this analysis, creating a dummy variable specification for every year incorporated in the analysis. The study uses price and cost data from 2011 to 2015 and M&A data from 2012 to 2014. The inclusion of *Year* also allows for the data alignment from various sources. The final independent variable, *State*, controls for state level effects which may have impacted the resulting estimates. Dafny, Ho, and Lee (2016) establish in their study that state level hospital markets are important in the sense that mergers and acquisitions within the same state do generate significant differences in prices post merger. The 2016 study examines beyond hospital referral region (HRR) markets

typically studied in hospital M&A analysis and shows that mergers and acquisitions do not matter between hospitals located in different states, suggesting that unique characteristics within state markets allow for significant price effects to occur after M&A (Dafny, Ho, and Lee, 2016). Based upon the results of Dafny, Ho, and Lee (2016), *State* also contributes to the propensity score by creating matches for consolidated hospitals within the same state to ensure that consolidated hospitals receive matches with unconsolidated hospitals which are subject to similar market characteristics.

B. Statistical Methodology

This paper uses two separate methods to estimate the econometric model. The study includes Ordinary Least Squares (OLS) estimates and three different propensity score matching methods: nearest neighbor, kernel, and stratification matching. Due to the fact that studies of hospital mergers and acquisitions are observational and these hospitals mergers and acquisitions do not occur randomly, certain estimations of the effects of hospital mergers and acquisitions may be biased due to an endogeneity problem. Identified by Dafny (2009), this problem arises from the difficulty of controlling for the motivation of every hospital merger and acquisition, potentially correlating the merger term with the error term in regressions. This study still uses OLS estimates to try to determine the effect of hospital mergers and acquisitions on revenue, quality, prices, and costs, but these estimates may be biased due to endogeneity because all merger motives are not controlled for.

To produce estimates not biased by endogeneity, three types of propensity score matching are also used. The hospitals are first separated on a basis of whether or not they underwent a merger or acquisition, and then an estimated propensity score is constructed with the staffed bed size, year of data, state, and hospital type. The estimated propensity scores are then used in the three propensity methods to create matches for comparison based upon the methodology of each propensity score method. In short, Nearest neighbor matching compares hospitals which are most like one another, kernel matching compares each merged hospital to the average of the unmerged, and stratification matching compares intervals of scores. These three methods prevent the endogeneity generated by this observational study by assuming that the treatment, in this case M&A, is exogenous, allowing for inferences to be made about the effects of the treatment. A detailed description of the three matching methods is available in Appendix A2.

CHAPTER FOUR

DATA SOURCES AND SAMPLE SELECTION

Chapter Four contains the data selection process and uses of data in this study. It includes an overview of the data sources, what variables were taken from each source, and their relevant limitations. Chapter Four also provides an explanation of how the data sample was constructed for this study and the descriptive statistics for the dependent variables.

A. Overview of the Data

To look at the price and cost effects of hospital mergers and acquisitions, this study gathers M&A data from Irving Levin Associates' publication, The Health Care Services Acquisition Report. Irving Levin Associates is a trusted provider of healthcare sector market intelligence for both investors and researchers (Irving Levin Associates, 2017). Irving Levin reports have been the primary provider of M&A information in many recent hospital studies, including Su (2017) and Schmitt (2017). Detailed hospital sector reports were obtained for the years 2012, 2013, and 2014. The reports provided the target acquisition hospital, ownership type, location, size, basic financial information, and deal structure, as well as the acquiring hospital name and location.

The analytical assessment of mergers and acquisitions can be problematic because of the risk of endogeneity, identified by Dafny (2009). A problem of endogeneity can occur because hospital mergers and acquisitions do not occur randomly, therefore the merger or acquisition term in analysis is likely correlated with the error term containing

the consolidation motivation. Although the deals provided by Irving Levin and Associates provided some of the motivations for M&A, the motivations can be tough to quantify and were not incorporated in every deal structure. Therefore, the mergers and acquisitions provided by Irving Levin Associates could very well suffer from the endogeneity when analyzed. The analysis done in this study on M&A effects mitigated for the endogeneity problem by using propensity score matching methods.

In order to select hospitals for comparison to ascertain the effects of M&A activity, a dataset was constructed from the most current American Hospital Directory. The American Hospital Directory is a national level provider of statistics on U.S. acute care hospitals (American Hospital Directory, 2017). Organized by state, the AHD directory provides cross-sectional data in the form of hospital name and total number of staffed beds, as well as the nominal gross revenue generated by providing care to patients. For the purposes of this analysis, the gross revenue values were chained to constant 2015 dollars. The American Hospital Directory compiles the state level data lists from a variety of reputable sources, including the Centers for Medicare and Medicaid Services and the Joint Commission. A limitation of the American Hospital Directory data is that archived databases are not available, therefore the data incorporated in this study is the most recent data available. Although the merged hospitals were assessed based upon their staffed bed count at the time of the merger, they were matched with hospitals based upon a more recent number of staffed beds. The lack of an archived database prevents a comparison of consolidated hospitals to the unconsolidated hospitals which were most like them at the time of the merger.

Hospital ownership type is a characteristic which has been examined for price and costs effects in the outstanding literature because hospitals of differing ownership types operate in different ways (Melnick, Keeler, and Zwanziger, 1999). This study sought to control for these effects by controlling for hospital ownership type. The cross-sectional hospital ownership type data came from Data Lists, a database broker for a wide variety of U.S. industries (Data Lists, 2018). Data Lists builds databases using a research team, who combines internet research and interview methods to construct the sets. The database divides hospitals into several ownership categories: Government, Voluntary Nonprofit, and Proprietary. Hospitals are further divided within Government and Voluntary Nonprofit, with Government divided between Federal, Hospital District, Local, and State, and Voluntary Nonprofit divided into Private, Church, and Other. This database is the most current available, with no archived data available, similar to the limitations of the American Hospital Directory data. Although the hospitals which underwent mergers and acquisitions used their hospital ownership status at the time of consolidation during the analyses, all other untreated hospitals were updated to this most recent ownership type, which may have created biased estimates if unconsolidated hospitals were to have converted ownership type in the defined time period, but were most like a consolidated hospital at the time of M&A.

Data Lists also provides data for the number of beds within the hospitals, similar to the information provided by the American Hospital Directory. The American Hospital Directory bed data was selected for this analysis because although the database provides fewer hospitals than Data Lists, the database provided by Data Lists did not provide a

number of beds for every hospital within the database and also did not specify if values provided for beds were the licensed or available staffed beds.

The measure of hospital quality used in this analysis was a measure of overall hospital performance derived from a weighted combination of scores in four areas of care. This data comes from the Hospital Value-Based Purchasing (HVBP) program, which is run by the Centers for Medicare and Medicaid Services. HVBP is an initiative which uses a combination of outcomes, patient experiences, safety, and cost reduction measures to measure quality of care in hospitals. The program adjusts Medicare reimbursement rates for hospitals based upon their HVBP scores (Centers for Medicare and Medicaid Services, 2017). The data used for this analysis for all hospitals comes from the December 2017 scores given to hospitals, the most current available, but may limit analysis because the hospitals were unable to be evaluated on their scores at the time of merger or acquisition or on a continual basis.

The panel nominal price and cost data for the selected diagnoses come from the Centers for Medicare and Medicaid Services (CMS) Provider Utilization and Payment Inpatient Database. Data sets were obtained for the years 2011 - 2015 and contain average price, cost, and discharge statistics for the 100 most common covered inpatient diagnoses for all U.S. hospitals which are certified by Medicare (Centers for Medicare and Medicaid Services, 2018). In this study, the price and cost values were chained to constant 2015 dollar to mitigate the effect of inflation. While prices are the amounts that hospitals attempt to receive for rendering medical services, costs are what Medicare and other payers of healthcare actually pay for these diagnoses. The final amount paid by

Medicare is a product of an algorithm which combines factors including identified diagnosis, severity of diagnosis, teaching hospital status, and proportion of patients served who are uninsured or who receive Medicaid. In an effort to encourage elevated quality of care, Medicare also linking an increasing portion of reimbursements to outcomes and quality of care delivered (Reinhardt, 2010). The open availability, national scope, and range of diagnoses included in the data made the Medicare set suitable for this analysis. The data is limited in the fact that Medicare only purchases care for senior Americans, so the inpatient diagnoses included are not reflective of the entire U.S. population. The data spans a sufficient number of years to ensure that all mergers and acquisitions assessed in this analysis have price and cost data available for one year prior and one year after the merger or acquisition event. A detailed description of the individual variables used in this study is available in Appendix A1.

B. Determination of the Sample

This paper originally draws from 9,074 hospitals located in the United States. Hospitals located outside of the 50 states or Washington D.C. were not used for this study because this paper specifically examines the effects of merger and acquisitions on the U.S. hospital market. Hospitals located outside of this geographic specification are subject to different healthcare delivery and payment systems, and may not have the same data available as the hospitals within the U.S. market. Beyond the geographic specification, the hospitals had to meet several criteria in order to be used in the final sample. The hospitals had to be general acute care, non specialty hospitals and reported

on by the American Hospital Directory to ensure availability of annual bed, gross patient revenue, and state data. Furthermore, the hospitals had to be Medicare certified. The final hospitals also had to be participants in the Hospital Values-Based Purchasing (HBVP) Program in 2017 for the included annual quality score. After applying these criterion, 3,277 hospitals were part of the final analysis, where 161 of these hospitals underwent consolidations in the years 2012 to 2014.

C. Descriptive Statistics

Descriptive statistics for the dependent variables of the 3,277 hospitals evaluated in this study can be found in Table 1. Surprisingly, the statistics show that consolidated hospitals have an average revenue in USD that is lower than that of unconsolidated hospitals, and less surprisingly have a lower average quality score out of 100 possible points. These statistics suggest that on average, hospitals which do not undergo M&A earn higher revenues and perform better on the Centers for Medicare and Medicaid Services (CMS) quality analysis. The CMS quality scores are an important figure which net hospitals higher reimbursement rates for higher scores, while comparatively high revenues are also important in an era where many hospitals struggle to keep their doors open. Based upon the descriptive statistics presented, consolidated hospitals need to work to increase both their revenues and quality in order to remain viable moving forward, particularly as quality dictates a greater percentage of compensation.

There were no significant differences found between the unmerged and unmerged hospital groups in terms of the average number of staffed beds. When rounded, both

merged and unmerged hospitals had an average of 227 staffed beds. The remainder of the descriptive statistics show very few significant differences between the two hospital groups, however, there are differences in the price in USD charged by hospitals for DRGs 039, 193, and 291, all demonstrating that hospitals which have undergone M&A charge less on average for the care provided for these diagnoses, potentially an indication of the reasoning for the lower average revenue. The varied number of observations for the overall hospital metrics as well as the diagnoses is reflective of the challenges of working with observational data. The overall hospital metrics provide averages based upon the entire sample of 3,277 hospitals, while each diagnosis looks at only a subset of these. This is due to the fact that although these diagnoses were selected from the 100 most common Medicare diagnoses, not all hospitals have a significant amount of cases in the data set or contain complete data for evaluation.

CHAPTER FIVE

EMPIRICAL RESULTS OF THE EFFECTS OF HOSPITAL M&A ON REVENUE, QUALITY, COSTS, AND PRICES

This chapter contains the summary of the empirical results gathered during this study, including estimates from both the OLS and propensity score matching method regressions. Additionally, this chapter compares the results of this study to published studies and reviews the potential limitations of these results.

A. Empirical Results

Estimates of the effects of mergers and acquisitions for all dependent variables using OLS and the three specified matching methods can be found in Tables 2 and 3 respectively. In Table 2, Columns 1 and 2 contain the estimates for all dependent variables for the Treatment and Beds regressors from the OLS regressions, while Columns 1, 2, and 3 in Table 3 contain the estimates for all dependent variables for the nearest neighbor, kernel, and stratification matching methods. A further explanation of the matching methods utilized is available in Appendix A2.

Both tables control for year, state, and hospital type differences which could bias the estimates. Although the results varied in significance and the coefficients may have varied due to the means of comparison used in the matching methodologies, the study found that the three matching method estimates are largely in support of each other.

Columns 1 and 2 of Table 2, displaying the Treatment and Beds OLS regressors, presented very different results in terms of quantities of significant values. All values for Beds in Column 2 had significant outcomes, with all positive coefficients with the

exception of *TotalPerformanceScore*, the quality measure. The negative quality coefficient demonstrates that having a greater number of beds decreases the quality of care delivered. It is important to note that the staffed beds data was scaled during analysis, where coefficients are equal to increases of 100 beds. The positive coefficient indicated that increasing hospital staffed bed size by 100 creates significant increases in revenue of about 40%. An increase of 100 beds was shown to generate significant increases in prices and costs for all included diagnoses. The *Treatment* results in Column 1 for the revenue and quality dependents were similar to the results of Column 2 in terms of coefficient sign and significance, finding that revenue significantly increased for consolidated hospitals, but quality significantly decreased. In terms of additional significant results, *Treatment* only suggested that there were significant decreases in the price for DRG 039 and the cost to Medicare for DRG 190 for hospitals which had undergone M&A.

Following the results found in Table 2, all three matching methods found in Table 3 indicate that consolidated hospitals experience significant increases in revenue when compared to their unconsolidated peers. Also similar to the results found in Table 2, both kernel and stratification matching support that hospitals which have undergone a merger or acquisition in the defined time period deliver significantly lower quality of care. When looking at prices and costs for the included diagnoses, all available matching methods display significant and negative results for the price of DRG 039, 190, 193, and 291, indicating that consolidated hospitals charge payers less for these diagnoses. The combination of negative price coefficients with increased revenues is a surprising one, as

revenue is a composite of prices. This is a potentially a function of consolidated hospitals serving more patients, or charging more for diagnoses not assessed in this analysis. Columns 3 and 4 both show negative and significant outcomes for the Medicare cost for DRG 039, as well as the price of DRG 282, showing comparatively lower cost and price for these diagnoses. The nearest neighbor and stratification matching methods both display that the cost to Medicare is lower for DRG 193. Of all three columns, the nearest neighbor method offered the most significant results, all of which were negative with the exception of the revenue variable. This outcome means that the comparison created by the nearest neighbor method of estimation generated the most significant differences between the hospital groups of all three methods of estimation attempted in Table 3. This shows that when hospitals are compared on this basis, consolidated hospitals experience lower quality, prices, and costs than their unconsolidated counterparts.

B. Comparison to the Literature

While considering the price and cost effects of mergers and acquisitions in this analysis, this study is largely in line with the findings of several of the previous studies (Connor et al. 1997; Lynk, 1995; Schmitt, 2017). Although his study looks specifically at the costs incurred to hospitals pre and post mergers, Schmitt (2017) finds that hospitals experience cost savings of between four percent and seven percent after undergoing a merger. The significant results found for the prices charged by consolidated hospitals as well as the results for Medicare and non-Medicare costs agree with the outcomes of the Schmitt (2017) study. In order for hospitals to post lower prices and accept lower

reimbursements from payers, a reduction in costs on their end is required for hospitals to keep their doors open.

Although this study does agree with several others, there are studies which it disputes as well. In their review of outstanding studies on the impacts of consolidation on price, Xu, Wu, and Makary (2015) assert that consolidated hospitals increase the prices charged and also increase the bargaining clout for hospitals to exact higher payments from insurers. This difference may be a reflection on the specific markets examined in the studies reviewed by Xu, Wu, and Makary (2015). The researchers focused on the California market, particularly California based insurers and the metropolitan hospital markets of Los Angeles and San Francisco. California is a densely populated state with close to 350 hospitals, with many of these hospitals located within the same county or metropolitan area. California's hospital market is also characterized by a large amount of consolidated hospital networks and a high number of mergers and acquisitions (American Hospital Directory, 2017). The results of the Xu, Wu, and Makary (2015) examination may in fact be a reflection of a market which is no longer competitive because of the large number of hospital systems and consolidations, while this study looks at a broader geographic range where consolidation activities could be helping to support hospital savings.

C. Limitations of the Results

This study presents OLS regressions which control for year, state, and hospital ownership type effects. Dafny (2009) suggests in her study that these types of regressions may suffer from endogeneity because hospitals do not undergo mergers and acquisitions randomly, and choose to partake in them for a wide variety of reasons, making it nearly impossible to control for all of these motivations to prevent a correlation with the error term. Although the estimates presented in this study may still suffer from endogeneity after the use of select controls, the use of the three propensity matching methods was incorporated to produce results theoretically unbiased by endogeneity.

The examination uses a Centers for Medicare and Medicaid Services performance score as a proxy for quality, however the performance score is not inclusive of a wide range of measures and is skewed to examine outcomes which are part of ongoing Medicare quality initiatives. Quality in healthcare is tough to define and may mean different things to different patients, therefore the quality results found by this study may not be the same if a different quality measure was selected.

The estimates presented in Tables 2 and 3 may be biased as a result of the data used in the analysis. Much of the data used, including staffed beds, revenue, quality, and hospital type were the most current values available for unconsolidated hospitals, with no previous data available for the years 2012 - 2014 that the mergers and acquisitions occurred in. In terms of revenue and quality, this curtailed the breadth of the analysis available for these dependent variables by only allowing for one year of analysis. All unconsolidated hospitals had staffed bed and hospital type data that was the most updated

available, preventing the matching of consolidated hospitals with the hospital that was most like them at the time of the merger or acquisition, a potential risk for the estimates.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

A. Summary of Study Findings

By creating a comparison between hospitals that underwent a merger or acquisition in 2012 through 2014 and hospitals which did not consolidate in that time period, this study examines the differences between these two groups in terms of prices charged by the hospitals for services, costs to Medicare and other healthcare payers, hospital revenue, and hospital quality. This study is the first to look at both prices charged by hospitals alongside the costs realized by healthcare payers while correcting for the endogeneity associated with hospital M&A analysis.

This analysis finds that regardless of whether or not a hospital underwent a consolidation activity, hospitals which have a greater number of beds have higher revenues, charges more for services and incur higher costs to payers, while quality decreases as the number of beds increases. This study also finds that hospitals which engaged in M&A in the defined time period generally had higher revenues, lower quality, and in the case of many diagnoses, posted lower prices and had lower costs for payers.

B. Implications of the Findings

The results of this study contribute to the widening debate on hospital M&A and how to best police it moving forward. Advocates for the prevention of hospital consolidation publicize that hospitals which have undergone mergers or acquisitions exert their market power to charge higher prices and elicit higher reimbursements from payers,

however this study does not support that claim and in fact directly disputes it with the results for several of the study diagnoses. However, an additional claim made by opponents of hospital M&A is that consolidated hospitals end up delivering lower quality care to patients. This argument is supported in this study, patients do receive significantly lower quality care in hospitals which merged between 2012 and 2014.

As hospitals struggle to remain secure in a market with quality tied reimbursements and ever increasing costs, a major motivation for hospitals to pursue mergers and acquisitions is to stabilize or increase their revenues. This study demonstrates that consolidated hospitals significantly increase their revenues, promoting this as a potential option for hospitals which may be struggling.

The above results contribute to a greater overall picture, the outcomes of this study indicate that hospital M&A is a viable way for hospitals to lower prices and costs to payers with respect to certain diagnoses while also increasing their revenues. Work still needs to be done in terms of pairing these successes with increased quality in order to achieve efficiency which encompasses both financial and quality metrics. Consolidated hospitals need to increase their quality in order to maintain their levels of reimbursement and make M&A a truly viable option.

The results of the analysis regarding the number of staffed beds available in a hospital, regardless of treatment, suggest that the attention of hospital price, cost, and quality watchdogs should be instead directed towards hospital bed size. While bed size does increase for a hospital organization as a result of hospital mergers or acquisitions, the results suggest that large hospitals are charging higher prices, have higher costs to

payers, and lower quality regardless of consolidation status, implying that M&A with significant bed size changes should be scrutinized, but hospitals which are already large or debating expansion should be investigated as well.

C. Limitations of the Study

The findings of this study are not without limitations. The results presented in the OLS regressions may suffer from the problem of endogeneity identified by Dafny (2009) due to the fact that hospital merger motivations are not controlled for in the OLS regressions because it is difficult to encompass all outstanding motivations. The estimates presented in all methods of estimation may be biased because revenue, quality performance, staffed bed, and hospital type data came from the most recent data available, creating a time mismatch between the consolidated and unconsolidated hospital information. This also curtailed the breadth of analysis on revenue and quality performance as only one year of data was available for these variables.

D. Suggestions for Future Research

The results of this study present an interesting question, future research could debate whether or not hospitals need to charge more in order to achieve higher quality outcomes. To further the work of this study, an expanded list of diagnoses could be included to gather more conclusive results, and matching hospitals within their direct Hospital Referral Region (HRR) could provide an interesting examination of the potential anti-competitive effects of hospital M&A. Additionally, if a greater range of payment data became publicly available, analysis on a lengthier history of hospital consolidation

could be completed. A separate study could look at what is occurring in terms of the results of lower prices combined with higher revenues to ascertain if hospitals are serving more patients or simply charging more for diagnoses not examined in this study.

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TABLES

Table 1. Descriptive statistics for variables

Variables	Unconsolidated Hospitals	Consolidated Hospitals
Overall Hospital Metrics		
Gross Patient Revenue *In Thousands of U.S. Dollars*	918,509.80 (56,618.90)	917,009.70 (20,403.14)*
Total Performance Score *Reported out of 100*	37.36 (0.19)	35.01 (0.83)*
Beds *Number of Staffed Beds*	226.96 (3.60)	227.47 (10.30)
Number of Observations	3,116	161
Diagnoses		
Medicare Payments 291 *Heart Failure & Shock w/ Complications or Comorbidities*	8,968.13 (51.26)	8,805.99 (154.62)
Average Total Payments 291 *Heart Failure & Shock w/ Complications or Comorbidities*	9,947.20 (56.69)	9,781.54 (171.25)
Average Covered Charges 291 *Heart Failure & Shock w/ Complications or Comorbidities*	35,792.90 (519.22)	30,301.89 (1,586.80)*
Number of Observations	1,634	86
Medicare Payments 039 *Extracranial Procedures without Complications or Comorbidities*	5,596.63 (35.25)	5,374.80 (87.85)
Average Total Payments 039 *Extracranial Procedures without Complications or Comorbidities*	7,228.69 (47.91)	7,027.89 (139.93)
Average Covered Charges 039 *Extracranial Procedures without Complications or Comorbidities*	32,123.72 (468.83)	26,542.59 (1,600.37)*
Number of Observations	987	57
Medicare Payments 190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*	6,726.65 (28.19)	6,648.34 (88.05)
Average Total Payments 190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*	7,967.70 (33.14)	7,862.92 (108.46)
Average Covered Charges 190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*	30,133.44 (335.47)	27,749.87 (1,327.42)

Number of Observations	2,891	154
Medicare Payments 193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	8,858.60 (34.64)	8,395.19 (110.21)
Average Total Payments 193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	9,806.925 (39.39)	9,665.70 (134.71)
Average Covered Charges 193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	37,821.97 (411.05)	33,672.82 (1,529.72)*
Number of Observations	2,787	150
Medicare Payments 282 *Acute Myocardial Infarction, Discharged Alive w/ out Complications or Comorbidities*	4,150.87 (38.67)	3,992.73 (118.25)
Average Total Payments 282 *Acute Myocardial Infarction, Discharged Alive w/ out Complications or Comorbidities*	5,392.43 (46.74)	5,273.36 (174.97)
Average Covered Charges 282 *Acute Myocardial Infarction, Discharged Alive w/ out Complications or Comorbidities*	25,068.05 (506.18)	2,1132.72 (1,620.34)
Number of Observations	635	38

Note: The above values are the observed means. The standard errors are below in parentheses. All monetary values are in constant 2015 dollars. Diagnosis definitions were provided by cms.gov. *An indication of that the observed mean of the consolidated hospitals is significantly different from the observed mean of the unconsolidated hospitals, $p<0.05$.

Table 2. Estimates of the effects of mergers and acquisitions using OLS with the log of revenue, log of performance, and logs of prices and costs for selected diagnoses as dependent variables.

		OLS Regressor Estimates	
Dependent Variables		**(1) Treatment**	**(2) Beds**
logGrossPatientRevenue *In U.S. Dollars*		0.231 (0.059)**	0.399 (0.006)**
	R-squared	*0.634*	
logTotalPerformanceScore *Reported out of 100*		-0.090 (0.023)**	-0.035 (0.002)**
	R-squared	*0.140*	
logMedicarePayments291 *Heart Failure & Shock w/ Complications or Comorbidities*		-0.003 (0.017)	0.036 (0.002)**
	R-squared	*0.379*	
logAverageTotalPayments291 *Heart Failure & Shock w/ Complications or Comorbidities*		-0.00090 (0.017)	0.039 (0.0019)**
	R-squared	*0.396*	
logAverageCoveredCharges291 *Heart Failure & Shock w/ Complications or Comorbidities*		-0.048 (0.0425)	0.076 (0.0047)**
	R-squared	*0.499*	
logMedicarePayments039 *Extracranial Procedures without Complications or Comorbidities*		-0.035 (0.020)	0.027 (0.0020)**
	R-squared	*0.410*	
logAverageTotalPayments039 *Extracranial Procedures w/out Complications or Comorbidities*		-0.012 (0.021)	0.029 (0.002)**
	R-squared	*0.402*	
logAverageCoveredCharges039 *Extracranial Procedures w/out Complications or Comorbidities*		-0.128 (0.0524)***	0.028 (0.005)**
	R-squared	*0.363*	
logMedicarePayments190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*		-0.0056 (0.013)***	0.031 (0.0015)**
	R-squared	*0.357*	
logAverageTotalPayments190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*		-0.010 (0.012)	0.034 (0.0014)**

	R-squared	*0.366*
logAverageCoveredCharges190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*	-0.0092 (0.0305)	0.063 (0.0035)**
	R-squared	*0.519*
logMedicarePayments193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	-0.0155 (0.0124)	0.031 (0.0014)**
	R-squared	*0.365*
logAverageTotalPayments193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	-0.012 (0.0121)	0.036 (0.0014)**
	R-squared	*0.380*
logAverageCoveredCharges193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	-0.0519 (0.032)	0.059 (0.0035)**
	R-squared	*0.490*
logMedicarePayments282 *Acute Myocardial Infarction, Discharged Alive w/out Complications or Comorbidities*	-0.00882 (0.0286)	0.024 (0.0029)**
	R-squared	*0.361*
logAverageTotalPayments282 *Acute Myocardial Infarction, Discharged Alive w/out Complications or Comorbidities*	0.002 (0.027)	0.031 (0.0027)**
	R-squared	*0.360*
logAverageCoveredCharges282 *Acute Myocardial Infarction, Discharged Alive w/out Complications or Comorbidities*	-0.016 (0.066)	0.060 0.0067**
	R-squared	*0.448*
Sample Size	3,277	

Note: The above values are the regression coefficients. The standard errors are below in parentheses. R-squared values are in italics. The values for beds represent a change of 100 beds. All monetary values are in constant 2015 dollars. Diagnoses definitions were provided by cms.gov.
*** = Significant at 1%, ** = Significant at 5%, * = Significant at 10%

Table 3. Estimates of the effects of mergers and acquisitions using matching methods with the log of revenue, log of performance, and the logs of prices and costs for selected diagnoses as dependent variables.

	Matching Methods Estimates		
Dependent Variables	**(1) Nearest Neighbor**	**(1) Kernel**	**(3) Stratification**
logGrossPatientRevenue *In U.S. Dollars*	0.550 (0.148)**	0.278 (0.088)***	0.310 (0.076)***
logTotalPerformanceScore *Reported out of 100*	-0.062 (0.038)	-0.091 (0.023)***	-0.106 (0.024)***
logMedicarePayments291 *Heart Failure & Shock w/ Complications or Comorbidities*	-0.031 (0.031)	-0.018 (0.019)	-0.027 (0.018)
logAverageTotalPayments291 *Heart Failure & Shock w/ Complications or Comorbidities*	-0.027 (0.025)	-0.017 (0.015)	-0.025 (0.016)
logAverageCoveredCharges291 *Heart Failure & Shock w/ Complications or Comorbidities*	-0.314 (0.101)**	-0.140 (0.051)***	-0.133 (0.056)**
logMedicarePayments039 *Extracranial Procedures without Complications or Comorbidities*	-0.050 (0.028)*	-0.042 (0.014)**	N/A
logAverageTotalPayments039 *Extracranial Procedures w/out Complications or Comorbidities*	-0.084 (0.040)***	-0.031 (0.023)	N/A
logAverageCoveredCharges039 *Extracranial Procedures w/out Complications or Comorbidities*	-0.367 (0.085)***	-0.233 (0.060)***	N/A
logMedicarePayments190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*	-0.045 (0.027)*	-0.012 (0.012)	-0.018 (0.014)
logAverageTotalPayments190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*	-0.054 (0.025)**	-0.017 (0.014)	-0.020 (0.013)
logAverageCoveredCharges190 *Chronic Obstructive Pulmonary Disorder w/ Major Complications or Comorbidities*	-0.270 (0.080)***	-0.085 (0.040)**	-0.063 (0.037)*
logMedicarePayments193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	-0.043 (0.021)**	-0.017 (0.013)	-0.023 (0.012)*
logAverageTotalPayments193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	-0.049 (0.030)	-0.014 (0.012)	-0.019 (0.015)

logAverageCoveredCharges193 *Simple Pneumonia & Pleurisy w/ Major Complications or Comorbidities*	-0.278 (0.072)***	-0.109 (0.033)***	-0.099 (0.046)**
logMedicarePayments282 *Acute Myocardial Infarction, Discharged Alive w/out Complications or Comorbidities*	-0.007 (0.034)	-0.031 (0.023)	-0.031 (0.029)
logAverageTotalPayments282 *Acute Myocardial Infarction, Discharged Alive w/out Complications or Comorbidities*	0.004 (0.042)	-0.022 (0.025)	-0.020 (0.031)
logAverageCoveredCharges282 *Acute Myocardial Infarction, Discharged Alive w/out Complications or Comorbidities*	-0.228 (0.111)**	-0.172 (0.071)**	-0.125 (0.079)
Sample Size	3,277	3,277	3,277

Note: The above values are the regression coefficients. The standard errors are below in parentheses. The values for beds represent a change of 100 beds. All monetary values are in constant 2015 dollars. N/A values resulted from diagnoses not having sufficient information to support the models. Diagnoses definitions were provided by cms.gov.
*** = Significant at 1%, ** = Significant at 5%, * = Significant at 10%

APPENDIX

APPENDIX A1
DETAILED DESCRIPTION OF VARIABLE CONSTRUCTION AND SOURCES

Note: All monetary values were chained to constant 2015 dollars to remove the effect of inflation from the analysis.

GrossPatientRevenue: Gross Patient Revenue is the "sticker price" for hospital services provided to patients during a fiscal year. This is the amount of U.S. dollars a hospital would receive for their services rendered if insurers did not negotiate lower rates or issue denials, or if hospitals did not provide charity care or fall victim to bad debts. Source: American Hospital Directory "Hospital Statistics by State".

TotalPerformanceScore: The total performance score received by a hospital is a combined score which comes from four equally weighted component scores. The first score is the clinical care domain, which looks at hospital mortality rates. The Patient Experience score is the second component and is derived from mandatory follow up services administered to Medicare patients after a stay in the hospital. The safety domain comes from a range of sources, including a patient safety measure, infection prevention measures, and delivery of care measures. The last component included to arrive at the total performance score is the efficiency and cost reduction component, which looks at Medicare Spending per Beneficiary. Hospitals must have scores in at least 3 of the 4 components to receive an overall score, and their final total performance score is the weighted average of all of their components, with an eligible range of 0 to 100 Source: Data.Medicare.gov Hospital Value-Based Purchasing (HVBP) - Total Performance Score

Database (https://data.medicare.gov/Hospital-Compare/Hospital-Value-Based-Purchasing-HVBP-Total-Perform/ypbt-wvdk).

MedicarePayments291: The average cost in USD to Medicare for patients with DRG 291: Heart Failure & Shock with Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

AverageTotalPayment291: The average total cost to patients and secondary insurances in USD for a diagnosis of DRG 291: Heart Failure & Shock with Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

AverageCoveredCharges291: The average total price in USD charged by hospitals for a diagnosis of DRG 291: Heart Failure & Shock with Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

MedicarePayments039: The average cost in USD to Medicare for patients with DRG 039: Extracranial Procedures without Complications or Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

AverageTotalPayments039: The average total cost to patients and secondary insurances in USD for a diagnosis of DRG 039: Extracranial Procedures without Complications or Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

AverageCoveredCharges039: The average total price in USD charged by hospitals for a diagnosis of DRG 039: Extracranial Procedures without Complications or Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

MedicarePayments190: The average cost in USD to Medicare for patients with DRG 190: Chronic Obstructive Pulmonary Disorder with Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

AverageTotalPayments190: The average total cost to patients and secondary insurances in USD for a diagnosis of DRG 190: Chronic Obstructive Pulmonary Disorder with Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

AverageCoveredCharges190: The average total price in USD charged by hospitals for a diagnosis of DRG 190: Chronic Obstructive Pulmonary Disorder with Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

MedicarePayments193: The average cost in USD to Medicare for patients with DRG 193: Simple Pneumonia & Pleurisy with Major Complications or Comorbidities. Source: Medicare, "The Inpatient Utilization and Payment Public Use File".

AverageTotalPayments193: The average total cost to patients and secondary insurances in USD for a diagnosis of DRG 193: Simple Pneumonia & Pleurisy with

Major Complications or Comorbidities. Source: Medicare, “The Inpatient Utilization and Payment Public Use File”.

AverageCoveredCharges193: The average total price in USD charged by hospitals for a diagnosis of DRG 193: Simple Pneumonia & Pleurisy with Major Complications or Comorbidities. Source: Medicare, “The Inpatient Utilization and Payment Public Use File”.

MedicarePayments282: The average cost in USD to Medicare for patients with DRG 282: Acute Myocardial Infarction, Discharged Alive without Complications or Major Complications or Comorbidities. Source: Medicare, “The Inpatient Utilization and Payment Public Use File”.

AverageTotalPayments282: The average total cost to patients and secondary insurances in USD for a diagnosis of DRG 282: Acute Myocardial Infarction, Discharged Alive without Complications or Major Complications or Comorbidities. Source: Medicare, “The Inpatient Utilization and Payment Public Use File”.

AverageCoveredCharges282: The average total price in USD charged by hospitals for a diagnosis of DRG 282: Acute Myocardial Infarction, Discharged Alive without Complications or Major Complications or Comorbidities. Source: Medicare, “The Inpatient Utilization and Payment Public Use File”.

Treatment: Hospitals which underwent a merger or acquisition between 2012 and 2014 were assigned a value of 1 for this dummy variable specification. These hospitals were identified through the use of yearly merger and acquisition reports for the years 2012, 2013, and 2014. All hospitals included in the analysis which did not undergo a

consolidation activity in the above specified years received a dummy variable value of "0". Source: Irving Levin Associates "The Health Services Acquisition Report" Years 2012, 2013, 2014.

Beds: This number is a measure of how many staffed beds all hospitals registered with the American Hospital Directory had in the year 2017. Staffed beds is the number of beds a hospital has adequate staff to provide care for within state legal guidelines. This number may differ from the amount of licensed beds a hospital has, which is the number of permitted beds in a hospital facility, regardless of staffing levels. Source: AHD "Hospital Statistics by State".

HospitalType: The ownership type of U.S. hospitals. This is defined by what type of organization the hospital is reported as for tax purposes, originally divided by Government, Voluntary Nonprofit, or Proprietary (For-profit). Government and Voluntary Nonprofit are further divided. Government is divided into Federal, State, Local, and Hospital District Authority while Voluntary Nonprofit is delineated by Private, Church, and Other. Source: Data Lists: "U.S. Hospital Database".

State: The state which each hospital included in the analysis is registered in. Each state received a dummy variable value which was equal to 1 when a hospital in that state was being assessed, or 0 when the hospital being assessed was from a different state. Source: AHD "Hospital Statistics by State".

APPENDIX A2
DESCRIPTION OF MATCHING METHODS USED FOR ESTIMATION

The three matching methods presented in this analysis are variations of propensity score matching. Propensity score matching is a statistical technique which seeks to determine the effect of a treatment or policy, making it suitable for examining the effect of the observational consolidation "treatment" in this study (Rosenbaum and Rubin, 1983). After being divided into consolidated and unconsolidated groups, the hospitals in this study received their propensity score based upon their number of staffed beds, the state in which their primary address is listed, and the year in which they underwent a merger or acquisition if one occurred at all. Once both the merged and unmerged hospital groups received their propensity score, they were compared via the three matching methods as described below. Each matching method uses a specific methodology to measure the differences between the consolidated and unconsolidated hospitals in an attempt to ascertain what effect hospital mergers and acquisitions have on the financial and quality outcomes evaluated in this study.

Nearest Neighbor Matching

Nearest neighbor matching is one of the most commonly used methods of propensity score matching and compares the treatment entities to the control entities which are most like them in terms of propensity score. Nearest neighbor matching first divides the treated and control groups and then randomly orders both groups. The first treated entity is then matched with the control entity with the propensity score which is

the shortest distance from its own score. The matching continues down the list until all of the treated entities receive a match. All control entities which do not match with a treatment entity are then discarded. Outputs for nearest neighbor matching represent the differences between a treated entity and the nearest available control comparator. This method effectively minimizes the difference between the estimated propensity scores for the two groups, considering the effects of treatment on entities by comparing entities which are most like each other based upon the contributing factors to the propensity score (Stuart, 2010).

Kernel Matching

Kernel Matching evaluates the differences between treatment and control groups by first computing the average of the propensity scores of all of the control entities. The propensity score of each treated entity is then compared to the computed average of the control entities, with the resulting output coefficients being the differences between the treated entity and the average of the control entities. Because kernel matching takes the average of the controls, this often lowers the variance of the outcomes, but also may not always be an example of the best matches because the treated entities may not always be similar to the entity represented by the average of the controls (Caliendo and Kopeining, 2008).

Stratification Matching

The goal of stratification matching is to eliminate bias which could arise from the underlying variables. After separating the propensity scores of the treated and control entities into two defined groups the propensity scores are ranked and stratified into five equal size groups. The corresponding quintiles are then compared, effectively demonstrating the differences between two stratums which theoretically have similar propensity scores, assuming the treated and control groups have propensity score ranges that are similar. The regression outputs show the average of the differences between the treated and control stratums (Austin, 2011).