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Examining The Relationship Between Surgical Profiles And Financial Performance Of Hospitals

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EXAMINING THE RELATIONSHIP BETWEEN SURGICAL PROFILES AND FINANCIAL PERFORMANCE OF HOSPITALS

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ADMINISTRATION – HEALTH SERVICES

ABSTRACT

Hospitals operate in turbulent and complex environments with limited resources. Consequently, administrators need to understand how to best use resources and improve a hospital's positioning in a market. Surgical services is a key operational activity for hospitals, thus, a better understanding of how these services are organized by hospitals likely has important implications for a hospital's performance and potentially survival. Given the potential importance of surgical services to hospitals, the purpose of this study was three-fold. First, the study identified different surgical profiles of hospitals based on the type and volume of surgical services provided by hospitals. Second, the study assessed whether these surgical profiles were associated with financial performance - defined as net patient revenue, total operating expense, and operating margin. Third, the study examined the moderating effects of local market characteristics on the relationship between surgical profiles and financial performance. This study found 6 surgical profiles of hospitals defined as: Specialist hospitals; No Focus hospitals; Cardiovascular Focus hospitals; Low Surgical Volume hospitals; High Surgical Volume hospitals; and Generalist hospitals. Hospitals differed in the types and volumes of procedures in predictable ways, yet these differences did not necessarily translate into differences in a hospital's bottom line financial performance. Surgical services are critical to performance and administrators need to understand the effects of adopting different surgical profiles and whether those profiles are associated with better or worst financial performance. From a practitioner perspective, the findings of the study point to new ways of thinking about managing the portfolio of surgical services offered at the organization. From a policy standpoint the findings of this study suggest uniform approaches to treating hospitals with respect to surgical profiles and payment systems may be misguided.

Keywords: Surgical profiles, net patient revenue, total operating expense, operating margin, local market characteristics, surgical operations

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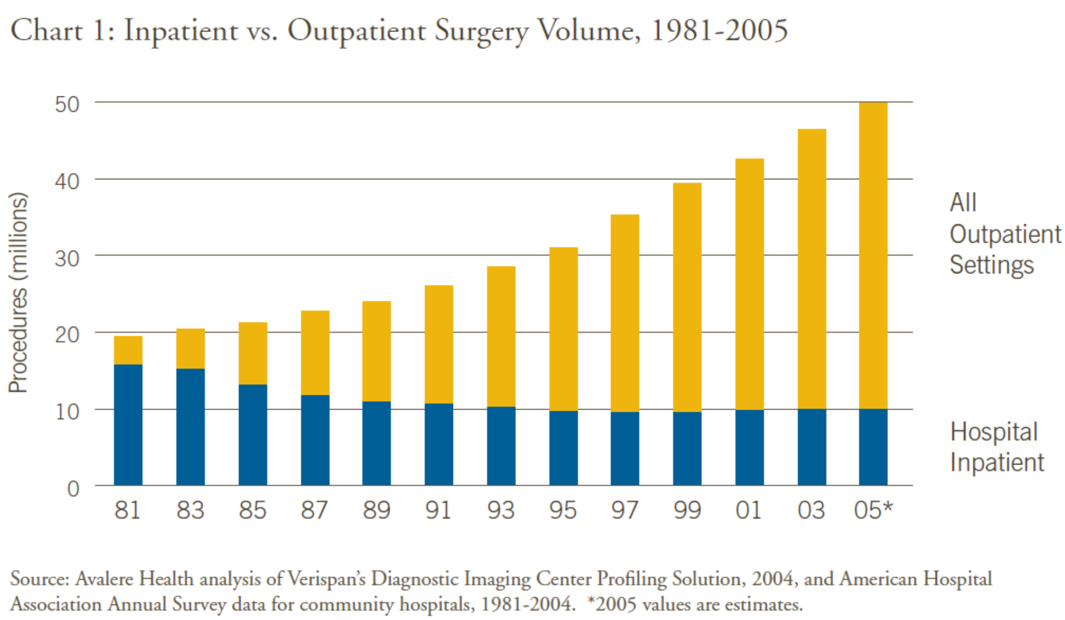
CHAPTER 1

INTRODUCTION

Financial performance is important for any organization to remain viable. Hospitals, like most organizations, also rely on financial performance to maintain their viability and pursue other initiatives/innovations that are important to stakeholders (e.g. process improvement that leads to better quality). Moreover, hospitals are complex organizations that exist within an increasingly turbulent and competitive environment (Baker, 2001; Carlisle, 2011; Choudhary, 2012; Kettelhut, 1992; Langabeer, 1998; Weeks & Wadsworth, 2013). The passage of the Affordable Care Act has added more turbulence due to its changes in payment methodologies that emphasize value and increased emphasis on accountability (Archambault, 2014; Graham, 2014).

The Surgical Services Department is a key hospital department for responding to these pressures and meeting financial goals, for several reasons. First, it generates a significant portion of a hospital's revenue (Plotzke & Courtemanche, 2010a, 2010b). Second, the number of surgical services provided by hospitals has steadily grown over the years (Figure 1). Finally, surgical services generate services and revenue for other departments, such as tissue acquisition, select radiology services, and pharmaceuticals, to name a few. Given the importance of surgical services for generating revenue for hospitals and the increased financial pressures facing hospitals, it is imperative that hospital leaders think strategically about their surgical service offerings (Swinehart, Zimmerer, & Oswald, 1995). Yet, surgical services occur in both inpatient and outpatient settings and span a wide range of surgical specialties, and thus, types of surgeries. Such a wide range of services and varying service volume due to different supply and demand functions presents a significant challenge for hospitals when trying to identify an optimal mix of surgical services.

Figure 1: Inpatient and outpatient surgical volume, 1981-2005



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Given the importance of surgical services to a hospital's financial health, the purpose of this study was three-fold (Figure 2). First, the study identified different surgical profiles of hospitals based on the type and volume of surgical services provided by hospitals. Second, the study assessed whether these surgical profiles were associated with differential financial performance. Third, the study examined the moderating effects of market characteristics on the relationship between surgical profiles and financial performance. In sum, this study addressed the following research questions:

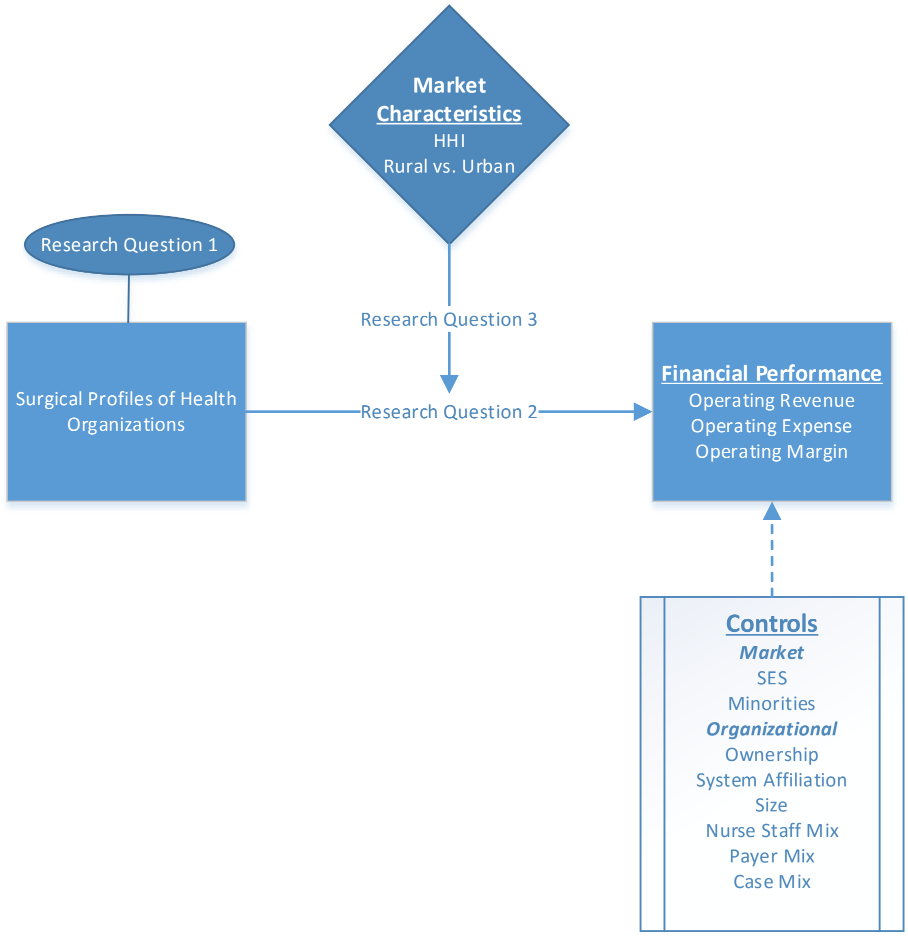
Research Question 1: What types of surgical profiles exist among hospitals?

Research Question 2: Are certain surgical profiles associated with better financial performance?

Research Question 3: Is the relationship between surgical profiles and financial performance moderated by local market characteristics?

Findings from the proposed study provide a basis to modify surgical services (e.g., expansion, recruitment of new specialties). Such considerations are particularly important given the importance of surgical services to a hospital's financial health. For example, if a provider retired or left the organization, instead of simply replacing that provider with a similar provider, considering what surgical profile type would optimize financial performance and recruiting that type of provider could improve the financial position of the organization. Likewise, findings from the study can inform decisions regarding expansion or contraction of certain specialties within the surgical services department and facilitate a better understanding of the financial implications of such decisions. A diagram outlining the study relationships are provided in Figure 2:

Figure 2: Overview of Study Questions and Relationships



The remainder of this dissertation is organized into four chapters. Chapter 2 provides the theoretical framework and reviews the relevant literature. Chapter 3 describes the data sources utilized, operationalization of variables, data set preparation and the analysis utilized for examining the research questions. Chapter 4 presents results from the analysis. Finally, Chapter 5 discusses the study findings and their implications for policy and practice.

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Surgical Profiles

Despite the importance of surgical services, little research has explicitly examined surgical profiles. One study attempted to group surgical services in a very limited fashion by grouping ambulatory surgery centers (ASCs) based on urological procedures and examined their relationship to expected changes in reimbursement (Strope, Daignault, Hollingsworth, Wei, & Hollenbeck, 2008). No research studies were found, however, that identified surgical profiles based on the entire suite of surgical services provided by a hospital. Nevertheless, the premise of this study is that surgical profiles can be thought of as consisting of two components or dimensions: 1. the types of surgical services provided by a hospital and 2. the volume of procedures performed within these types of services.

Despite the absence of research explicitly examining surgical profiles, there is other research that is useful in guiding this study. For example, in the human resources literature, MacDuffie (1995) argued that “bundles” of HR practices may act synergistically to affect performance. Empirical results supported this conceptualization, showing HR bundles being more effective at promoting desired employee outcomes such as motivation, satisfaction, and lower burnout. MacDuffie concluded that combining certain sets of HR practices can maximize performance by supporting and/or reinforcing each practice, while combinations of other HR practices could undermine performance.

For example, extrinsic reward systems such as pay for performance can undermine other motivating HR practices such as general recognition.

Consistent with these ideas, we hypothesize that hospitals may adopt different combinations of surgical services. This variation exists because the types of surgical services offered by a hospital and the number of services provided for these types of surgical services vary as a function of organizational and environmental characteristics. For example, surgical volume can be influenced both by reimbursement and management pressure (C. T. Wilson, Fisher, Welch, Siewers, & Lucas, 2007; N. A. Wilson, Schneller, Montgomery, & Bozic, 2008). Increases in reimbursement for certain types of procedures can cause organizations to increase focus within those areas or hospital leadership could increase focus within a surgical service specialty (e.g. urology, ophthalmology) based on popularity in industry trade magazines as well as reactions to the competitive environment. Service line specialization can also influence surgical volume by contributing more resources to one service line over another to increase a hospital's specialization within that service line (e.g. cardiac or trauma) (Capkun, Messner, & Rissbacher, 2012; N. P. Wilson et al., 2013).

Surgical Profiles and Financial Performance

In this study, I also argue that certain combinations of surgical services may result in varying levels of organizational performance, in this case financial performance. For example, some combinations of services may allow a hospital to maximize utilization of their operating rooms and enhance revenues. Likewise, some combinations of surgical services may reduce waste with respect to staffing resources or supplies, which in turn may reduce operating expenses. While it is reasonable to think different surgical profiles may be associated with variable financial performance, given the paucity of research in this area and the absence of predefined surgical profiles, it is not possible to offer formal, *a priori* hypotheses. Therefore, the first study objective was considered exploratory with the goal of identifying different types of surgical profiles that would serve as predictors of financial performance.

A variety of financial performance measures exist, such as profitability, liquidity, capital structure, operating margin, operating revenue, operating cost, and utilization (Pink et al., 2006). Given that the primary focus of this proposed research study is surgical services, an operational unit of the organization, operational measures are the preferred measures of financial performance. Therefore, the study will focus on operating margin as the primary measure of financial performance. However, operating margin may mask the manner by which surgical profiles may influence financial performance (e.g., higher operating revenue, lower operating costs). Therefore, the study will also include two additional measures of financial performance – operating revenue and operating expense – that may shed light on how surgical profiles may drive financial performance.

The search of the literature identified twenty-four articles describing the relationship between organizational factors and financial performance within hospitals. Little of this research, however, has examined what surgical services are drivers of operating financial performance. Only six articles examined the association between aspects of an organization's surgical services and financial performance (Dexter & Ledolter, 2003; Dexter & O'Neill, 2004; Franklin et al., 2005; Monakova et al., 2010; O'Neill & Franklin, 2004; Strope et al., 2008) and these studies tended to be narrow in focus and very few studies have been conducted at the hospital level to assess the overall portfolio of surgical services. For example, Strope et al. (2008) focused on urologic procedures to classify ambulatory surgery centers (ASCs). Such studies, while valuable, are not likely to be as pertinent to a chief executive officer (CEO) or chief medical officer (CMO) trying to determine how best to organize surgical resources across the organization. Because so few studies focused on surgical attributes and financial performance, the literature discussed below will include other research that looks at financial performance and hospitals more generally.

Factors that were found to significantly influence operating cost include length of stay, lower mortality rates, location, ownership status, and volume (Stock & McDermott, 2011). In a study conducted by Schneider et al. (2007), the socioeconomic status of patients, case mix, payer mix, bed size, and competition were found to influence operating margin, operating revenue, and operating expenses. Monakova et al. (2010) found that case mix, when controlling for patient demographics, was the best measure to equitably divide national funding for trauma patients within the Canadian health system. Dexter and Ledolter (2003) examined surgeon's contribution margin (revenues less expenses) per operating room hour to determine the best mix of surgeons for an organization. Their analysis found that changing the surgeon specialty mix currently employed at the hospital produced little effect. These studies contain variables that should be controlled in this study such as case mix, payer mix, demographics, and size.

Moderating Influence of Market Characteristics

Based on insights from contingency theory, we argue that some surgical profiles will be associated with better financial performance under certain environmental conditions. The primary focus of Contingency Theory is the fit between an organization's structure and strategy and its external environment (Miner, 2005). That is, organizations must look at the internal characteristics of the organizations, including "structure and orientation", to determine the "goodness of fit" between the environment and the organization (Lawrence & Lorsch, 1986, p.209; Miner, 2005). Organizations will typically attempt to improve alignment with their external environment by making internal adaptations, oftentimes via differentiation, which then creates a need for integration. Studies have found some support for the argument that better fit between an organization's internal structure and its environment is associated with better performance (Dalmau-atarrodona & Puig-junoy, 1998; Raju, Lonial, Gupta, & Ziegler, 2000; Rosko, 1999).

Geographic location and level of competition, in particular, may be important environmental conditions to consider as moderating the relationship between surgical profiles and financial performance. This importance exists because surgical profiles may be developed and adapted to meet the unique supply and demand functions that vary as a function of these environmental characteristics. For example, a surgical profile that emphasizes procedures that can be provided in higher volume (or exclusively) on an outpatient basis may be financially advantageous in a rural market where the supply of skilled surgeons is lower and a critical mass of patients needing intensive, inpatient surgical services is not present. Similar to the main effect relationships, however, I consider this portion of the study exploratory as it depends upon the identification of different surgical profiles. Therefore, formal, a priori hypotheses are not offered at this point.

Summary

The premise of this study is that hospital leaders make decisions about the types of surgical services to offer and that variations across hospitals in the volume of surgeries follow from these decisions. It is also assumed that such decisions are based on factors (e.g., revenue potential, patient population, surgeon supply) that result in different groupings, or profiles, of surgical services across hospitals. And while the overall surgical activities of a hospital may vary as a function of a number of factors, I submit that surgical profiles vary primarily across two dimensions: 1. Which types of surgical services to offer and 2. The volume of services provided within these different categories of surgical services.

Assuming different surgical profiles exist, it is reasonable to believe that these profiles may have variable impact on a hospital's financial performance. We also argue that geographic location and competition are contingency factors in the relationship between surgical profiles and financial performance. That is, we submit that some surgical profiles may be associated with better financial performance when they are better suited to the local environment (e.g., demands of local geographic conditions, competitiveness of local market as contingent factors). The following chapter will outline the methods used to examine these relationships.

CHAPTER 3

METHODS

Data Sources

The study utilized data from five sources. First, the Health Care Utilization Project's State Inpatient Database and Ambulatory Surgical Center Database provided inpatient and outpatient surgical service data, respectively. Second, the American Hospital Association (AHA) Annual Survey data set provided hospital characteristic data including ownership status, system affiliation, payer mix, size, and nurse staff mix. Third, the Area Resources File (ARF) provided sociodemographic data and market characteristic data relevant to this study. Fourth, the Medicare Cost Reports provided financial data used to determine operating revenue, operating expenses, and operating margin of the hospitals. Finally, the Centers for Medicare & Medicaid Services' (CMS) Payment Impact File was used to determine the case mix index. All data will be for 2009, 2010, and 2011. The study focused on hospitals from three states: California, Florida, and New York. These three states were chosen because each of these states are geographically representative of major regions in the U.S. and contain diverse patient populations. The study sample was narrowed further to hospitals that provide surgical services. The first four data sets were linked using AHA and Medicare identifiers unique to each hospital.

The ARF was merged based on the Federal Information Processing Standard (FIPS) at the county-level.

Dependent Variables

Three dependent variables were included in the analysis: 1. Operating revenue, as reported in the Medicare Cost Report; 2. Operating expense, as reported in the Medicare Cost Report; and 3. Operating margin, calculated as operating revenue minus operating expense divided by operating revenue. These variables were averaged across 2009-2011 to assess "sustained performance" and account for year-to-year fluctuations that do not reflect overall performance. Any fiscal year lengths that were below 364 days were annualized by dividing the number of days in the fiscal year for net patient revenue and total operating expense then multiplied by 365 days.

Independent Variables

Surgical profile. The operationalization of the surgical profile variable(s) began by collecting surgical medical severity diagnosis related group (MS-DRG) Codes (inpatient surgical cases) and current procedural terminology clinical classifications software for services and procedures (CPTCCS) Codes (outpatient surgical cases). Unique codes identified in this process were then categorized by a surgical nurse consultant with over 40 years of industry experience, including over 20 years of surgical consulting experience with over 100 organizations in all regions of the U.S., to predefined surgical specialty categories (e.g., general surgery, urology, plastics), which in turn were used to create a crosswalk of DRG and CPTCCS codes to a surgical specialty category. The categories were mutually exclusive such that a single DRG or CPTCCS code was assigned to one category. Based on the primary DRG and/or CPTCCS code, patient level cases were assigned to one of these surgical specialty categories. If a code could be assigned to two different categories, one category was chosen dependent on the number of occurrences found in the dataset. This occurrence was minimal compared to the number of categorizations. The number of individual cases within each category was then summed to create hospital-level variables that reflected the number of cases per year for each surgical category. The use of these variables to construct a surgical profile is described in more detail in the analytic strategy.

Moderating Variables

Location was operationalized as a dichotomous variable (1 = urban; 0 = rural), where an urban location was defined as a hospital located in a county with a population of 50,000 or more (U.S. Census). Competition was measured with the Herfindahl-Hirschman Index (HHI). The Herfindahl index ranges from zero to one and is a measure of industry competition where a value of one indicates a monopolistic market and values approaching zero indicate highly competitive markets. The Herfindahl index was calculated at the county-level using the sum of hospital beds for hospitals in a given area to compute the level of concentration in a market. The formula for calculating the Herfindahl Index is below:

$$HHI = \sum_{i=1}^{N} s_i^2$$

where *s* is the market share of hospital *i* in the county and *N* is the number of hospitals in the county.

Control Variables

Hospital socioeconomic variables (age, sex, income) and minority status (White, Hispanic, African American) utilized continuous variables based on the measures found in the ARF, such as percentage of residents in a county over the age of 65, percentage of residents in a county with income below the federal poverty level, the percentage of county residents that are female, and the percentage of county residents that are minorities. Hospital ownership status was measured dichotomously based on a hospital's status in the initial study year (2011), where for-profit hospitals were coded as 1 and not-for-profit hospitals were coded as 0. Hospital size was measured with a continuous variable based on the number of beds set up and staffed for use. Payer mix was measured with two continuous variables: 1. percentage of total inpatients that are Medicare recipients and 2. percentage of total inpatients that are Medicaid recipients. System affiliation was measured dichotomously based on a hospital's status in the initial year (2011), where a hospital that is a member of a multihospital system was coded 1 and all other hospitals were coded as 0 (1 = system, 0 = independent). Nurse staff mix is a continuous variable calculated as the average number of RN FTEs for 2009-2011 divided by the total average number of nurse FTEs for 2009-2011. An additional hospital-level control variable, case mix index, was obtained from the CMS Payment Impact File. The case mix index is the average DRG relative weight for a hospital, calculated as the sum of the DRG weights for all Medicare discharges divided by the number of discharges. Table 1 provides the variable name, types of variable, and data source.

Table 1: Variable Description

Variable	Dependent Variable	Variable Type	Data Source
Dependent	Operating Revenue	Continuous Variable (Collected)	Medicare Cost Report
Dependent	Operating Expense	Continuous Variable (Collected)	Medicare Cost Report
Dependent	Operating Margin	Continuous Variable (Calculated)	Medicare Cost Report
Independent	Surgical Profile	Composite Variable(s) (Appropriate Combination of Surgical Specialties based on Factor Analysis) (Calculated/Analyzed)	H-CUP
Independent	Competition	Continuous Variable (HHI) (Calculated)	AHA Annual Survey
Independent	Location	Dichotomous Variable (Urban [≥50,000 population]/Rural[<50,000 population]) (Designated)	ARF
Control	Ownership Status	Dichotomous Variable (for-profit & not-for-profit) (Collected)	AHA Annual Survey
Control	Minority Status	Continuous Variable (Collected)	ARF
Control	Socioeconomic Status	Continuous Variables (Age, Sex, Income, etc.) (Collected)	ARF
Control	Size	Continuous Variable (Collected)	AHA Annual Survey
Control	System Affiliation	Dichotomous Variable (Affiliated/Not Affiliated)	AHA Annual Survey
Control	Payer Mix	Categorical Variable (Calculated)	AHA Annual Survey
Control	Case Mix	Continuous Variable (Collected)	CMS Payment Impact File
Control	Nurse Staff Mix	Continuous Variable (Collected)	AHA Annual Survey

Proposed Analysis

The study was a pooled, cross-sectional study utilizing data from Florida, California, and New York hospitals that performed surgical services. The unit of analysis was the hospital, pooling data for the years of 2009-2011. The proposed study included univariate, bivariate, and multivariate analyses. Diagnostic tests were first conducted to assure that assumptions were not violated (such as histograms, Box’s M Test, Equal Means, and multivariate normality). A description of the specific analytic strategy for each research question is detailed below.

Research Question 1

Latent class analysis was used to identify different types of surgical profiles. The three-year data period was aggregated into one dataset and treated as a single point in time to determine the latent classes. Hospital-level sums for each surgical category were divided into quartiles (initial attempts to run the analysis using sums resulted in models that failed to converge on a maximum likelihood solution), which were then used to construct a dichotomous variable indicating high volume. Specifically, hospitals were assigned a 1 if they were in the 75th percentile or higher with respect to the number of surgeries for a surgical specialty and 0 if they were less than the 75th percentile. This dichotomous variable was then utilized for the latent class analysis to identify unique surgical profiles. Similar to the goals of cluster analysis, latent class analysis (a form of mixture modeling) is a technique that can be used to identify unobserved subgroups comprised of similar observations. Unlike clustering techniques, however, latent class analysis is a model-based technique that uses posterior membership probabilities (rather than dissimilarity measures) to assign observations to a subgroup. Because it is based in a structural equation framework, latent class analysis also provides more objective indicators of subgroup solutions than traditional clustering techniques (Wang & Wang, 2012). Dummy variables were created for each (mutually exclusive) latent class to represent whether a hospital is a member of that class (i.e., profile).

Research Question 2

An ordinary least squared (OLS) regression was used to examine the relationship between the surgical profiles and financial performance. The natural log of net patient revenue and the natural log of total operating expense were used as the dependent variables. The formula below provides a general model specification for this analysis.

$$\mathrm{Y}_i = \beta_0 + \beta_1 X_i + \beta_k X_i + e_i$$

Where *i* represents an individual hospital.

Research Question 3

The moderating influence of location and competition entailed the use of a OLS. Specifically, for this question, the regression models used to address Research Question 2 (baseline models) were extended by adding multiplicative interaction terms to the model. One set of interaction terms focused on the interaction between geographic location and surgical profile, created by multiplying the dichotomous rural/urban variable with the surgical profile dummy variables (final number of interactions terms based on the number of profiles identified in the LCA). A second set of interaction terms that focused on the interaction between competition and surgical profile were created by multiplying the Herfindahl Index with the surgical profile dummy variables (final number of interactions terms, again, based on the number of profiles identified in the LCA). These interaction terms were then added to the baseline models. The formulas below provide an example of the model specification for the analysis.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_i + \beta_3 X_i \ldots + \beta_k X_k + \beta_k (\textit{Surgical Profile}_i)^*(\textit{Urban}_i) +$$
$$\beta_k (\textit{Surgical Profile}_i)^*(\textit{HHI}_i) + e_i$$

Assessments of the moderational influence was based on the significance of specific interaction terms and the change in the adjusted R-square between the interaction models and the base models.

Data Set Preparation

The fully merged data set began with 2,376 observations. One-hundred ten (110) observations were removed due to erroneous data (such as operating margin of -31,278%) and missing values in the dependent variable. Data across the 2009-2011 period were averaged for all applicable variables to create the pooled cross-section data set. The resulting data set included 774 observations. When examining the histograms for each of the dependent variables, both net patient revenue and total operating expense variables were significantly negatively skewed (see Appendix A) while operating margin was approximately normally distributed (see Appendix). To address this skewness, net patient revenue and total operating expense variables were log transformed (see Appendix A). The decision not to log transform the operating margin is consistent with the methods employed by other researchers (Li, Schneider, & Ward, 2009; Singh, Wheeler, & Roden, 2012; Weech-Maldonado et al., 2012). The resulting data set was then utilized to conduct the analyses.

CHAPTER 4

RESULTS

Overview

This chapter presents the results of the study. The chapter begins with the results from the latent class analysis, then moves to univariate and bivariate results for the entire sample as well as for each of the latent classes. Next the regression models are presented, concluding with the results from the moderation analysis.

Latent Class Analysis

The study began with Latent Class Analysis to determine how many surgical profiles existed for hospitals within the sample. Various latent class structures were considered and fit statistics suggested that a 6-class solution provided the best fit (Table 2). Lower AIC, ABIC, and ALMR LR as well as high entropy indicate better fitting models when examining different class solutions. ALMR LR looks at the relative goodness of fit to the previous model where the p-value is important to note. As shown in this table, the AIC and ABIC were smaller for larger classes and the entropy was high and the ALMR LR test for a 7-class solution was nonsignificant, suggesting that a 6-class solution was preferred. Each of the hospitals were then assigned to one mutually exclusive latent class based on their posterior class-membership probability given each hospital's response pattern on the observed categorical items (i.e., high-volume surgery for each surgery type).

A 'heat map' (see Figure 3) was created to assist in developing names for each of the latent classes. To do so, 6 separate colors were applied to the class probabilities to visually rank each class for each of the surgical specialty categories. Each number in Figure 3 refers to the percentage of hospitals within that latent class that were within the fourth

quartile for surgical volume within that specialty. For example, the value for Orthopedic under Latent Class 5 is 1.000 means that 100% of the hospitals assigned to latent class 5 were at or above the 75^{th} percentile in terms of the number of orthopedic surgeries.

When looking at the 'heat map', hospitals appear to vary along two dimensions: volume and surgical focus. Based on these variations, the latent classes were assigned the following labels: Specialists, No Focus, Cardiovascular Focus, Low Surgical Volume, High Surgical volume, and Generalists. "Low Surgical Volume" (latent class 4) hospitals were those below the 75^{th} percentile for all surgical procedures, while "High Surgical Volume" (latent class 5) hospitals were those that were above the 75^{th} percentile for all surgical procedures. "Specialist" hospitals (latent class 1) were those hospitals that tended to be above the 75^{th} percentile for many surgical specialty procedures (e.g., plastic surgery, thoracic surgery), but lower volume for more general procedures (e.g., GI, general surgery). "No Focus" hospitals (latent class 2) lacked focus on a specific surgical area and instead provided modest levels of surgeries across most types of all surgical services. "Cardiovascular" hospitals (latent class 3) focused on the cardiovascular specialties. Finally, "Generalist" hospitals (latent class 6) provided high numbers of gastrointestinal, general, and oral surgeries while providing intermediate numbers of other types of surgeries.

Table 2: Latent Class Analysis Fit Statistics

LCA Fit Statistics

Model	AIC	ABIC	ALMR LR	p-value	Entropy
1-class model	13824.4	13854	N/A	N/A	N/A
2-class model	10416.2	10476.8	3433.99	<.0001	0.954
3-class model	9774.79	9866.24	685.022	<.0001	0.942
4-class model	9555.83	9678.19	265.253	0.07	0.934
5-class model	9402.12	9555.41	200.409	0.0949	0.956
6-class model	9309.14	9493.34	140.081	0.0023	0.957
7-class model	9250.39	9465.5	106.071	0.1722	0.958

Figure 3: Latent Class " Heat Map" and Latent Class Titles

HEAT MAP

Variables	Latent Class 1	Latent Class 2	Latent Class 3	Latent Class 4	Latent Class 5	Latent Class 6
Orthopedics	0.700	0.429	0.341	0.003	1.000	0.248
Plastics	0.941	0.486	0.155	0.003	0.937	0.216
Podiatry	0.584	0.391	0.146	0.042	0.677	0.361
Thoracic	0.907	0.177	0.491	0.000	1.000	0.089
Transplant	0.136	0.066	0.030	0.005	0.553	0.065
Oral	0.299	0.362	0.055	0.043	0.760	0.340
Ophthalmology	0.397	0.419	0.130	0.040	0.786	0.327
Open Heart	0.640	0.026	0.583	0.003	1.000	0.114
Non-Surgical	0.538	0.163	0.436	0.070	0.850	0.169
Neurosurgery	0.773	0.135	0.252	0.042	0.969	0.219
Maxillofacial	0.520	0.459	0.053	0.015	1.000	0.185
Hand	0.545	0.411	0.109	0.022	0.889	0.412
GYN	0.601	0.271	0.289	0.038	0.722	0.287
GI	0.581	0.000	0.048	0.005	1.000	1.000
General	0.463	0.000	0.000	0.000	1.000	0.899
ENT	0.724	0.585	0.104	0.015	0.916	0.202
Diagnostic	0.516	0.277	0.232	0.064	0.918	0.202
Cardiovascular	0.846	0.070	0.608	0.003	0.967	0.188
Cardiology	0.681	0.000	0.689	0.003	0.807	0.105
Bariatric	0.176	0.092	0.045	0.019	0.387	0.083
Urology	0.818	0.527	0.154	0.005	0.971	0.165
Ungrouped	0.890	0.219	0.404	0.010	1.000	0.230
Trauma	0.319	0.276	0.152	0.012	0.624	0.115
Latent Class Titles	Specialists	No focus	Cardiovascular focus	Low surgical Volume	High surgical volume	Generalist

Legend

Highest
High
Medium
Medium Low
Low
Lowest

Table 3: Descriptive and Bivariate Statistics 1 of 2

Overall Class (n = 774), Class 1 (n = 40), Class 2 (n = 86), Class 3 (n = 73), Class 4 (n = 65), Class 5 (n = 87), Class 6 (n = 423)

Variables	Overall Mean ± Standard Deviation or % of total	Class 1 Mean ± Standard Deviation or % of total	Class 2 Mean ± Standard Deviation or % of total	Class 3 Mean ± Standard Deviation or % of total	Class 4 Mean ± Standard Deviation or % of total	Class 5 Mean ± Standard Deviation or % of total	Class 6 Mean ± Standard Deviation or % of total	Global P-value
Average Net Patient Revenue Annualized	$210,000,000 ± $288,000,000	$966,000,000 ± $622,000,000[†@$§‡]	$467,000,000 ± $264,000,000[#@†$‡§]	$251,000,000 ± $156,000,000[#@§]	$238,000,000 ± $89,000,000[#@§]	$207,000,000 ± $139,000,000[#@§]	$75,900,000 ± $81,000,000[#@†‡§]	p < 0.001
Log Transformed Avg Net Patient Revenue Annualized	18.49 ± 1.24	20.52 ± 0.57[@†$§‡]	19.83 ± 0.50[#@†$‡§]	19.14 ± 0.68[#@§]	19.22 ± 0.38[#@§]	18.93 ± 0.67[#@§]	17.70 ± 0.98[#@†‡§]	p < 0.001
Average Total Operating Expense Annualized	$216,000,000 ± $305,000,000	$974,000,000 ± $650,000,000[@†$§‡]	$497,000,000 ± $343,000,000[#@†$‡§]	$268,000,000 ± $165,000,000[#@§]	$223,000,000 ± $87,000,000[#@§]	$220,000,000 ± $161,000,000[#@§]	$75,700,000 ± $74,900,000[#@†‡§]	p < 0.001
Log Transformed Avg Total Operating Expense Annualized	18.50 ± 1.24	20.52 ± 0.58[@†$§‡]	19.85 ± 0.56[#@†$‡§]	19.20 ± 0.70[#@§]	19.15 ± 0.41[#@§]	18.96 ± 0.72[#@§]	17.71 ± 0.97	p < 0.001
Average Operating Margin Annualized	-3% ± 23%	-1% ± 12%	-4% ± 31%	-9% ± 33%[$]	6% ± 14%[†]	-4% ± 21%	-3% ± 21%[$]	0.007
Member of a System	62%	68%	63%	52%[$]	77%[†]	64%	60%	0.053
For-Profit Hospital	28%	0%	10%[$§]	14%[$§]	43%[@†‡]	9%[$§]	38%[@†‡]	p < 0.001
General Medical Hospital	86%	100%	95%[§]	84%	98%[§]	97%[§]	78%[@$‡]	p < 0.001
Average Staffed Beds	236 ± 244	733 ± 406[@†$§‡]	468 ± 298[#@†$‡§]	254 ± 144[#@§]	293 ± 110[#@§]	257 ± 159[#@§]	126 ± 136[#@†‡§]	p < 0.001
HHI	0.27 ± 0.27	0.18 ± 0.13[‡]	0.20 ± 0.20[‡§]	0.19 ± 0.22[‡§]	0.28 ± 0.23	0.33 ± 0.29[#@†]	0.30 ± 0.29[@†]	p < 0.001

Pairwise comparison statistical significance (p < 0.10): [#]Comparisons to class 1 "Specialists" , [@]Comparisons to class 2 "No Focus" , †Comparisons to class 3 "Cardiovascular Focus" , [$]Comparisons to class 4 "Low Surgical Volume" , ‡Comparisons to class 5 "High Surgical Volume" , [§]Comparisons to class 6 "Generalists"

Table 4: Descriptive and Bivariate Statistics 2 of 2

Overall Class (n = 774), Class 1 (n = 40), Class 2 (n = 86), Class 3 (n = 73), Class 4 (n = 65), Class 5 (n = 87), Class 6 (n = 423)

Variables	Overall Mean ± Standard Deviation or % of total	Class 1 Mean ± Standard Deviation or % of total	Class 2 Mean ± Standard Deviation or % of total	Class 3 Mean ± Standard Deviation or % of total	Class 4 Mean ± Standard Deviation or % of total	Class 5 Mean ± Standard Deviation or % of total	Class 6 Mean ± Standard Deviation or % of total	Global P-value
Nurse Staff Mix	0.58 ± 0.44	0.89 ± 0.26 [$§]	0.75 ± 0.39 [$§]	0.72 ± 0.40 [§]	0.55 ± 0.47 [#@‡]	0.77 ± 0.77 [$§]	0.45 ± 0.43 [#@†‡]	p < 0.001
Average CMI	1.13 ± 0.64	1.81 ± 0.20 [†‡§]	1.55 ± 0.39 [†§]	1.24 ± 0.53 [#@$§]	1.62 ± 0.17 [†§]	1.40 ± 1.40 [#§]	0.83 ± 0.62 [#@†$‡]	p < 0.001
Hospital in Urban Area	86%	100%	98% [§]	96% [§]	97% [§]	87%	79% [@†$]	p < 0.001
Percentage of Average Medicare Inpatients Days	48%	41% [$§]	47% [†$]	38% [@$‡§]	54% [#@†‡]	46% [†$]	49% [#†]	p < 0.001
Percentage of Average Medicaid Inpatients Days	23%	22%	22% [‡]	28% [$§]	18% [†‡]	28% [@§]	22% [†‡]	p < 0.001
Percentage of Population that is Female	51%	51% [§]	51% [§]	51% [§]	51% [§]	51% [§]	50% [#@†$‡]	p < 0.001
Percentage of Population that is Minority	22%	29% [$‡§]	24%	25% [§]	21% [#]	24% [#]	21% [#†]	p < 0.001
Percentage of Population over 65	15%	13% [$]	14% [$]	14% [$]	17% [#@†‡§]	14% [$]	14% [$]	p < 0.001
Percentage of Population in Poverty	17%	17%	17%	16%	16%	17%	17%	0.031
Percentage of Population without Highschool Degree	17%	16%	16%	17%	15%	17%	17%	0.013

Pairwise comparison statistical significance ($p < 0.10$): [#]Comparisons to class 1 "Specialists" , [@]Comparisons to class 2 "No Focus" , †Comparisons to class 3 "Cardiovascular Focus" , [$]Comparisons to class 4 "Low Surgical Volume" , ‡Comparisons to class 5 "High Surgical Volume" , [§]Comparisons to class 6 "Generalists"

Descriptive Statistics

Surgical Profiles – Independent Variable of Interest

The Generalist class of hospitals was the largest class with 423 hospitals, or 55% of the entire sample. The other classes ranged from 40 hospitals (Specialist Hospitals) to 87 hospitals (High Surgical Volume Hospitals). Since the Generalist class of hospitals represented the prevalent surgical profile, it was assigned to be the referent group when discussing class differences in the multivariate analyses.

Financial Performance – Dependent Variables

The overall average annualized net patient revenue for the sample was $210.0 million, with a range of $75.9 million (Generalist hospitals) to $966.0 million (Specialist hospitals). The overall average annualized total operating expense for the sample was $216 million, with a range of $75.7 million (Generalist Hospitals) to $974 million (Specialist Hospitals). The average operating margin for the overall sample was -3%, with a range of -9% (Cardiovascular Focus Hospitals) to 6% (Low Surgical Volume Hospitals). Due to the complexity and high cost of cardiac procedures coupled with a higher Medicare population, running a profitable cardiovascular service can be difficult.

Moderating Variables

Overall 666 hospitals (86%) were located in urban markets and 108 hospitals (14%) were located in suburban/rural markets. The Generalist Hospital class had the fewest urban hospitals, with 79% of them located in urban markets, while the Specialist hospital class had the most urban hospitals (100% being located in urban markets). The average competition, as measured by the HHI, was 0.27 for the overall sample. Hospitals in the Specialist class were operating in the least competitive markets (0.18), on average, while hospitals in the High Surgical Volume class were operating in the most competitive markets (0.33).

Control Variables

Overall 480 (62%) of the sample hospitals were members of a health system. Among these, hospitals in the Cardiovascular Focus class had the lowest membership at 52% and hospitals in the Low Surgical Volume class had the highest system membership at 77%. As for ownership, 28% of hospitals in the sample were for-profit hospitals. Hospitals in the Specialist class were all not-for-profit hospitals while 43% of the hospitals in the Low Surgical Volume class were for-profit. Most hospitals (86%) were general medical hospitals with the others being specialty hospitals. Hospitals in the Generalist class for surgical profiles tended to have the most specialty hospitals (22%) while hospitals in the Specialist class for surgical profiles had the most general medical hospitals (100%). Specialist hospitals such as single specialty hospitals tend to perform more general surgeries. The average number of staffed beds for the sample was 236 beds. The Generalist class had the fewest staffed beds (126 beds), on average, while the Specialist class had the most staffed beds (733 beds). Nurse staff mix averaged 58% RN staff overall, with the Generalist class exhibiting the lowest level (45%) of RN staffing and the Specialist class of hospitals having the highest level (89%).

The study hospitals reported an average CMI of 1.13, with a range of 0.83 (Generalist class hospitals) at the low end to 1.89 (Specialist class hospitals) at the high end. Average Medicare inpatient days as a percentage of total inpatients days for the sample was 48%. Hospitals in the Cardiovascular Focus class (38%) had the fewest number of Medicare patients while hospitals in the Low Surgical Volume class (54%) had the most. Overall, average Medicaid inpatients days as a percentage of total inpatients days for the sample was 23%, with a range of 18% (Low Surgical Volume hospitals) at the lower end and a tie for the highest at 28% (Cardiovascular and High Surgical Volume hospitals).

The percentage of females in each market for the overall sample was 51% and all classes had similar percentages in their respective markets. The percentage of minorities in markets overall was 22%, with hospitals in the Low Surgical Volume and Generalist classes (21%) having the lowest percentage of minorities and hospitals in the Specialist class (29%) having the highest percentage of minorities. The percentage of the population over the age of 65, overall, was 15%. Hospitals in the Specialist class were operating in slightly younger communities, with 13% of the population over the age of 65, while hospitals in the Low Surgical Volume class were operating in older communities (17% over age 65). The percentage of population in poverty overall was 17% and hospitals in all classes were operating in comparable communities with respect to poverty. Finally, the percentage of the population without a high school degree overall was 17% overall. Hospitals in the Low Surgical Volume class were operating in communities with a higher percentage of educated population (15%) while hospitals in the Cardiovascular Focus, High Surgical Volume and Generalist Hospitals classes were operating in similar environments in terms of education (17% of population without a high school degree).

Bivariate Results

Overview

Pairwise comparisons by class are indicated in Tables 3 and 4 through the use of unique symbols. Significance for the pairwise comparisons was indicated for all p-values $< .10$. When examining the differences between classes (Tables 3 and 4), globally all classes differ significantly for all of the covariates ($p < .05$ except for system membership at $p < .10$) thus every class is significantly different from one another. The bivariate analysis compared community and structural differences and found statistically significant differences between hospitals with different surgical profiles with respect to their structural and community characteristics. However, the range of values suggest that not all of these differences are necessarily practically meaningful. For the purposes of this study and the results presented below, practically significant differences will be defined as those that have a 4% variation in range or greater across classes.

Practically Significant Differences

Significance was found for nearly all of the classes based on average net patient revenue and average total operating expense except for the following class comparisons: Low Surgical Volume Hospitals versus Cardiovascular Hospitals, High Surgical Volume Hospitals versus Cardiovascular Hospitals, and High Surgical Volume Hospitals versus Low Surgical Volume Hospitals. Some of these differences are driven in part by the average bed size of hospitals in each class and size is controlled for within the regression models. The log transformed version of each of these variables had identical pairwise results as their component variables. Contrary to average net patient revenue and average total operating expense, average operating margin did not significantly differ between the surgical profiles except for two instances: Low Surgical Volume Hospitals versus Cardiovascular Hospitals and Generalist Hospitals versus Low Surgical Volume Hospitals.

The two moderating variables for local market characteristics in the study included HHI and location. HHI bivariate significance exists for the following comparisons: Specialist versus High Surgical Volume Hospitals; No Focus versus both High Surgical Volume and Generalist Hospitals; Cardiovascular Focus versus both High Surgical Volume and Generalist Hospitals; High Surgical Volume versus Specialists, No Focus, and Cardiovascular Focus Hospitals; and Generalist versus both No Focus and Cardiovascular Focus Hospitals. Location bivariate significance exists for the following comparisons: No Focus versus Generalist Hospitals; Cardiovascular Focus versus Generalist Hospitals; Low Surgical Volume versus Generalist Hospitals; and Generalist versus No Focus, Cardiovascular Focus, and Low Surgical Volume Hospitals. As for the control covariates, significance ranges from no significance for percentage of population in poverty and percentage of population with no high school diploma to average staffed beds having the most pairwise significances.

Multivariate Analyses

Six ordinary least square regression models – three baseline models and three interaction models - were evaluated for each of the outcome variables to examine the relationship between hospital surgical profile and financial performance. The sections below, organized by dependent variable, discuss these findings. In sum, the analysis revealed a statistically significant difference between each of the classes (surgical profiles) and two of the outcome variables; log transformed annualized average net patient revenue and log transformed annualized average total operating expense (Tables 5 and 7). In contrast, there were no significant differences between classes with respect to operating margin (Table 9). The analysis did not reveal any evidence of a moderating effect of local market characteristics on these relationships (Tables 11, 13, and 15).

Log Transformed Net Patient Revenue Annualized and Surgical Profile Regression Model

Overall, the covariates included in the analysis accounted for over 79% of the variation between hospitals with respect to the 3-year average annualized net patient revenue (adjusted R^2=0.792). Holding everything constant, hospitals in the Specialist class reported 164 percent higher 3-year average annualized net patient revenue than hospitals in the Generalist class ($p < .01$). Holding everything constant, hospitals in the High Surgical Volume class reported 60 percent higher 3-year average annualized net patient revenue when compared to hospitals in the Generalist class ($p < .01$).

Post-hoc comparisons of all surgical profiles (Table 6) also revealed a number of statistically significant differences between hospitals in the different surgical profiles. Holding everything constant, hospitals in the High Surgical Volume Class reported 39 percent lower 3-year average annualized net patient revenue compared to hospitals in Specialist class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 62 percent lower 3-year average annualized net patient revenue compared to hospitals in Specialist class ($p < .01$). Holding everything constant, hospitals in the High Surgical Volume class reported 38 percent lower 3-year average annualized net patient revenue compared to hospitals in No Focus Hospital class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 61 percent lower 3-year average annualized net patient revenue compared to hospitals in No Focus class ($p < .01$). Holding everything constant, hospitals in the High Surgical Volume class reported 22 percent less 3-year average annualized net patient revenue compared to hospitals in Cardiovascular Focus class ($p < .10$). Holding everything constant, hospitals in the Generalist class reported 52 percent lower 3-year average annualized net patient revenue compared to hospitals in Cardiovascular Focus class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 50 percent lower 3-year average annualized net patient revenue compared to hospitals in Low Surgical Volume class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 38 percent lower 3-year average annualized net patient revenue compared to hospitals in High Surgical Volume class ($p < 0.01$).

Table 5: Log Transformed Average Net Patient Revenue Annualized OLS Regression Model

Log Transformed Net Patient Revenue	Coef.	Reverse Transformed Coef. *	Std. Err.	95% Confidence Interval		P-value
Specialist Hospitals	0.972	164.323	0.126	0.723	1.220	p < 0.001
No Focus Hospitals	0.947	157.796	0.084	0.781	1.112	p < 0.001
Cardiovascular Focus Hospitals	0.724	106.267	0.078	0.571	0.877	p < 0.001
Low Surgical Volume Hospitals	0.685	98.377	0.086	0.516	0.853	p < 0.001
High Surgical Volume Hospitals	0.471	60.159	0.075	0.324	0.618	p < 0.001
Generalist Hospitals	Referent	Referent	Referent	Referent	Referent	-
Member of a System	0.225	25.274	0.046	0.136	0.315	p < 0.001
Not a Member of a System	Referent	Referent	Referent	Referent	Referent	-
For Profit Hospital	-0.214	-19.268	0.056	-0.325	-0.103	p < 0.001
Not for Profit Hospital	Referent	Referent	Referent	Referent	Referent	-
General Med/Surg Hospital	-0.042	-4.093	0.084	-0.207	0.123	0.619
Not General Med/Surg Hospital	Referent	Referent	Referent	Referent	Referent	-
Staffed Beds	0.001	0.139	0.000	0.001	0.002	0.000
% of RNs / Total Nurses	0.331	39.230	0.052	0.229	0.433	0.000
Case Mix Index	0.649	91.351	0.052	0.547	0.751	0.000
% of Females	0.025	2.492	0.017	-0.010	0.059	0.158
% of Minorities	0.010	1.053	0.002	0.006	0.015	0.000
% of Population 65+	0.006	0.616	0.006	-0.005	0.018	0.291
% of Population in Poverty	-0.024	-2.353	0.007	-0.038	-0.009	0.001
% of Population w/o High School Diploma	0.020	1.970	0.006	0.008	0.031	0.001
Hospitals in Urban Location	0.132	14.073	0.090	-0.045	0.308	0.143
Hospitals in Suburban/Rural Location	Referent	Referent	Referent	Referent	Referent	-
Herfindahl-Hirschman Index	-0.033	-3.283	0.111	-0.251	0.184	0.763
% of Medicare Inpatients / Total Inpatients	-0.425	-34.599	0.229	-0.874	0.024	0.064
% of Medicaid Inpatients / Total Inpatients	-0.126	-11.795	0.249	-0.614	0.363	0.614
Constant	15.486		0.853	13.811	17.161	p < 0.001
Sample size				772		
Adjusted R-Squared				0.792		
F Statistic			$F(20, 751) = 147.50, p < 0.01$			

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula $(\exp(\beta) - 1)*100$

Table 6: Post-Hoc Estimations for Pairwise Comparisons of classes of 3-year average annual net patient revenue

Surgical Profile	Contrast	Reverse Transformed Coef. *	Std. Error	Bonferroni 95% Conf. Interval		P-value
No Focus versus Specialist Hospitals	-0.025	-2.473	0.114	-0.362	0.312	1.000
Cardiovascular Focus versus Specialist Hospitals	-0.248	-21.942	0.130	-0.630	0.134	0.847
Low Surgical Volume versus Specialist Hospitals	-0.287	-24.953	0.130	-0.669	0.095	0.408
High Surgical Volume versus Specialist Hospitals	-0.501	-39.391	0.127	-0.874	-0.128	0.001
Generalist versus Specialist Hospitals	-0.972	-62.152	0.126	-1.344	-0.599	p < 0.001
Cardiovascular Focus versus No Focus Hospitals	-0.223	-19.963	0.096	-0.507	0.061	0.317
Low Surgical Volume versus No Focus Hospitals	-0.262	-23.050	0.098	-0.551	0.027	0.115
High Surgical Volume versus No Focus Hospitals	-0.476	-37.854	0.092	-0.747	-0.204	p < 0.001
Generalist versus No Focus Hospitals	-0.947	-61.192	0.084	-1.195	-0.698	p < 0.001
Low Surgical Volume versus Cardiovascular Focus Hospitals	-0.039	-3.858	0.103	-0.341	0.263	1.000
High Surgical Volume versus Cardiovascular Focus Hospitals	-0.253	-22.354	0.093	-0.527	0.021	0.099
Generalist versus Cardiovascular Focus Hospitals	-0.724	-51.513	0.078	-0.953	-0.494	p < 0.001
High Surgical Volume versus Low Surgical Volume Hospitals	-0.214	-19.238	0.097	-0.501	0.073	0.430
Generalist versus Low Surgical Volume Hospitals	-0.685	-49.568	0.086	-0.937	-0.432	p < 0.001
Generalist versus High Surgical Volume Hospitals	-0.471	-37.554	0.075	-0.691	-0.251	p < 0.001

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula $(\exp(\beta) - 1)*100$

Log Transformed Total Operating Expense Annualized and Surgical Profile Regression Model

Overall, the study covariates accounted for over 80% of the variation between hospitals with respect to their 3-year average annualized total operating expenses (adjusted $R^2 = .803$; Table 7). Holding everything constant, hospitals in the No Focus class reported a 153 percent higher 3-year average annualized total operating expenses than hospitals in the Generalist class ($p < 0.01$). Holding everything constant, High Surgical Volume Hospitals reported a 59 percent higher 3-year average annualized total operating expenses than hospitals in the Generalist class ($p < 0.01$).

Post-hoc comparisons of all surgical profiles (Table 8) also revealed a number of statistically significant differences between hospitals in the different surgical profiles. Holding everything constant, hospitals in the High Surgical Volume class reported 36 percent lower 3-year average annualized total operating expenses compared to hospitals in Specialist class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 60 percent lower 3-year average annualized total operating expenses compared to hospitals in Specialist class ($p < .01$). Holding everything constant, hospitals in the Low Surgical Volume class reported 26 percent lower 3-year average annualized total operating expenses compared to hospitals in the No Focus class ($p < .05$). Holding everything constant, hospitals in the High Surgical Volume class reported 37 percent lower 3-year average annualized total operating expenses compared to hospitals in the No Focus class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 60 percent lower 3-year average annualized total operating expenses compared to hospitals in the No Focus class ($p < .01$). Holding everything constant, hospitals in the High Surgical Volume class reported 23 percent lower 3-year average annualized total operating expenses compared to hospitals in the Cardiovascular Focus class ($p < .05$). Holding everything constant, hospitals in the Generalist class reported 52 percent lower 3-year average annualized total operating expenses compared to hospitals in the Cardiovascular Focus class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 47 percent lower 3-year average annualized total operating expenses compared to hospitals in the Low Surgical Volume class ($p < .01$). Holding everything constant, hospitals in the Generalist class reported 37 percent lower 3-year average annualized total operating expenses compared to hospitals in the High Surgical Volume class ($p < .01$).

Table 7: Log Transformed Average Total Operating Expenses Annualized OLS Regression Model

Log Transformed Total Operating Expense	Coef.	Reverse Transformed Coef. *	Std. Err.	95% Confidence Interval		P-value
Specialist Hospitals	0.908	147.827	0.123	0.666	1.149	p < 0.001
No Focus Hospitals	0.928	152.944	0.082	0.767	1.089	p < 0.001
Cardiovascular Focus Hospitals	0.732	107.933	0.076	0.583	0.881	p < 0.001
Low Surgical Volume Hospitals	0.628	87.471	0.084	0.464	0.792	p < 0.001
High Surgical Volume Hospitals	0.465	59.170	0.073	0.322	0.607	p < 0.001
Generalist Hospitals	Referrent	Referrent	Referrent	Referrent	Referrent	-
Member of a System	0.154	16.605	0.045	0.066	0.241	0.001
Not a Member of a System	Referrent	Referrent	Referrent	Referrent	Referrent	-
For Profit Hospital	-0.273	-23.874	0.055	-0.380	-0.165	p < 0.001
Not for Profit Hospital	Referrent	Referrent	Referrent	Referrent	Referrent	-
General Med/Surg Hospital	-0.005	-0.509	0.082	-0.165	0.155	0.950
Not General Med/Surg Hospital	Referrent	Referrent	Referrent	Referrent	Referrent	-
Staffed Beds	0.001	0.145	0.000	0.001	0.002	p < 0.001
% of RNs / Total Nurses	0.332	39.352	0.051	0.232	0.431	p < 0.001
Case Mix Index	0.619	85.729	0.051	0.520	0.715	p < 0.001
% of Females	0.023	2.357	0.017	-0.010	0.057	0.170
% of Minorities	0.012	1.217	0.002	0.007	0.017	0.000
% of Population 65+	0.006	0.562	0.006	-0.005	0.017	0.322
% of Population in Poverty	-0.023	-2.310	0.007	-0.038	-0.009	0.001
% of Population w/o High School Diploma	0.018	1.811	0.006	0.007	0.029	0.002
Hospitals in Urban Location	0.126	13.483	0.087	-0.045	0.298	0.148
Hospitals in Suburban/Rural Location	Referent	Referent	Referent	Referent	Referent	-
Herfindahl-Hirschman Index	-0.068	-6.530	0.108	-0.279	0.144	0.530
% of Medicare Inpatients / Total Inpatients	-0.495	-39.047	0.222	-0.932	-0.058	0.026
% of Medicaid Inpatients / Total Inpatients	-0.044	-4.289	0.242	-0.519	0.431	0.856
Constant	15.639		0.830	14.011	17.268	p < 0.001
Sample size				772		
Adjusted R-Squared				0.803		
F Statistic			F (20, 751) = 158.39, p < 0.01			

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula (exp(β) – 1)*100

Table 8: Post-Hoc Estimations for Pairwise Comparisons of classes for 3-year average annual operating expenses

Surgical Profile	Contrast	Reverse Transformed Coef. *	Std. Error	Bonferroni 95% Conf. Interval		P-value
No Focus versus Specialist Hospitals	0.020	2.065	0.111	-0.307	0.348	1.000
Cardiovascular Focus versus Specialist Hospitals	-0.176	-16.097	0.126	-0.547	0.196	1.000
Low Surgical Volume versus Specialist Hospitals	-0.279	-24.354	0.126	-0.651	0.092	0.408
High Surgical Volume versus Specialist Hospitals	-0.443	-35.774	0.123	-0.806	-0.080	0.005
Generalist versus Specialist Hospitals	-0.908	-59.649	0.123	-1.270	-0.546	p < 0.001
Cardiovascular Focus versus No Focus Hospitals	-0.196	-17.795	0.094	-0.472	0.080	0.554
Low Surgical Volume versus No Focus Hospitals	-0.300	-25.885	0.096	-0.580	-0.019	0.026
High Surgical Volume versus No Focus Hospitals	-0.463	-37.073	0.090	-0.728	-0.199	p < 0.001
Generalist versus No Focus Hospitals	-0.928	-60.466	0.082	-1.170	-0.686	p < 0.001
Low Surgical Volume versus Cardiovascular Focus Hospitals	-0.104	-9.841	0.100	-0.397	0.190	1.000
High Surgical Volume versus Cardiovascular Focus Hospitals	-0.267	-23.451	0.090	-0.533	-0.001	0.048
Generalist versus Cardiovascular Focus Hospitals	-0.732	-51.908	0.076	-0.955	-0.509	p < 0.001
High Surgical Volume versus Low Surgical Volume Hospitals	-0.164	-15.096	0.095	-0.443	0.115	1.000
Generalist versus Low Surgical Volume Hospitals	-0.628	-46.658	0.084	-0.874	-0.382	p < 0.001
Generalist versus High Surgical Volume Hospitals	-0.465	-37.174	0.073	-0.679	-0.251	p < 0.001

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula $(\exp(\beta) - 1)*100$

Average Operating Margin and Surgical Profile Regression Model

The study covariates accounted for slightly more than 10% of the variation between hospitals with respect to their 3-year average operating margins (adjusted R^2 = .107; Table 9). Four of the control covariates were statistically significant ($p < .05$) which included system membership, profit status, case mix index, and percentage of minorities. The post-hoc comparisons (Table 10) show no statistically significant differences between any of the surgical profiles.

Table 9: Average Operating Margin OLS Regression Model

Operating Margin	Coef.	Std. Err.	95% Confidence Interval		P-value
Specialist Hospitals	0.071	0.049	-0.025	0.167	0.148
No Focus Hospitals	0.005	0.033	-0.059	0.069	0.874
Cardiovascular Focus Hospitals	-0.024	0.030	-0.083	0.035	0.429
Low Surgical Volume Hospitals	0.053	0.033	-0.013	0.118	0.113
High Surgical Volume Hospitals	0.004	0.029	-0.053	0.060	0.903
Generalist Hospitals	referent	referent	referent	referent	-
Member of a System	0.084	0.018	0.050	0.119	p < 0.001
Not a Member of a System	referent	referent	referent	referent	-
For Profit Hospital	0.049	0.022	0.007	0.092	0.024
Not for Profit Hospital	referent	referent	referent	referent	-
General Med/Surg Hospital	-0.047	0.033	-0.111	0.016	0.146
Not General Med/Surg Hospital	referent	referent	referent	referent	-
Staffed Beds	0.000	0.000	0.000	0.000	0.197
% of RNs / Total Nurses	0.002	0.020	-0.038	0.041	0.932
Case Mix Index	0.041	0.020	0.001	0.080	0.044
% of Females	0.009	0.007	-0.004	0.022	0.185
% of Minorities	-0.003	0.001	-0.005	-0.001	0.003
% of Population 65+	-0.002	0.002	-0.006	0.003	0.462
% of Population in Poverty	0.001	0.003	-0.005	0.007	0.741
% of Population w/o High School Diploma	0.002	0.002	-0.003	0.006	0.465
Hospitals in Urban Location	-0.014	0.035	-0.083	0.054	0.680
Hospitals in Suburban/Rural Location	referent	referent	referent	referent	-
Herfindahl-Hirschman Index	0.035	0.043	-0.050	0.119	0.421
% of Medicare Inpatients / Total Inpatients	0.121	0.089	-0.053	0.295	0.172
% of Medicaid Inpatients / Total Inpatients	-0.107	0.096	-0.296	0.083	0.270
Constant	-0.530	0.331	-1.180	0.119	0.109
Sample size			772.000		
Adjusted R-Squared			0.107		
F Statistic			F (20, 751) = 5.60, p < 0.01		

Table 10: Post-Hoc Estimations for Pairwise Comparisons of Surgical Profiles for 3-year Average Annualized Operating Margin

Surgical Profile	Contrast	Std. Error	Bonferroni 95%		P-value
No Focus versus Specialist Hospitals	-0.066	0.044	-0.196	0.065	1.000
Cardiovascular Focus versus Specialist Hospitals	-0.095	0.050	-0.243	0.053	0.894
Low Surgical Volume versus Specialist Hospitals	-0.018	0.050	-0.166	0.130	1.000
High Surgical Volume versus Specialist Hospitals	-0.067	0.049	-0.212	0.077	1.000
Generalist versus Specialist Hospitals	-0.071	0.049	-0.215	0.073	1.000
Cardiovascular Focus versus No Focus Hospitals	-0.029	0.037	-0.139	0.081	1.000
Low Surgical Volume versus No Focus Hospitals	0.048	0.038	-0.064	0.160	1.000
High Surgical Volume versus No Focus Hospitals	-0.002	0.036	-0.107	0.104	1.000
Generalist versus No Focus Hospitals	-0.005	0.033	-0.102	0.091	1.000
Low Surgical Volume versus Cardiovascular Focus Hospitals	0.077	0.040	-0.040	0.194	0.807
High Surgical Volume versus Cardiovascular Focus Hospitals	0.027	0.036	-0.787	0.134	1.000
Generalist versus Cardiovascular Focus Hospitals	0.024	0.030	-0.065	0.113	1.000
High Surgical Volume versus Low Surgical Volume Hospitals	-0.049	0.038	-0.161	0.062	1.000
Generalist versus Low Surgical Volume Hospitals	-0.053	0.033	-0.151	0.045	1.000
Generalist versus High Surgical Volume Hospitals	-0.004	0.029	-0.089	0.082	1.000

Log Transformed Net Patient Revenue Annualized and Surgical Profile Moderated by Local Market Characteristics Regression Model

Hospitals in the Specialist class were omitted from moderation analysis due to a lack of variation in their geographic location, with all hospitals being located in urban markets. The second regression model accounted for nearly 80% of the variation between hospitals with respect to their 3-year average net patient revenue annualized (adjusted $R^2 = .792$; Table 11). There was no change in the adjusted R^2 for this model compared to the model without the interactions. There were no significant moderating influences for competition or location. Post-hoc comparison between all classes (Table 12) revealed four significant moderating influences when comparing the surgical profiles; Generalist versus No Focus; Generalist versus Cardiovascular Focus; Generalist versus Low Surgical Volume; and Generalist versus High Surgical Volume. Due to the lack of change in the adjusted R^2, these differences do not point to notable moderating influences.

Table 11: 3-year Average Net Patient Revenue Annualized Regression Results, Interaction between Surgical Profile and Competition

Log Transformed Net Patient Revenue	Coef.	Reverse Transformed Coef. *	Std. Err.	95% Confidence Interval		P-value
Specialist Hospitals	1.070	191.675	0.171	0.735	1.405	p < 0.001
No Focus Hospitals	1.241	245.935	0.492	0.275	2.208	0.012
Cardiovascular Focus Hospitals	0.047	4.842	0.483	-0.901	0.995	0.922
Low Surgical Volume Hospitals	0.606	83.306	0.500	-0.375	1.587	0.226
High Surgical Volume Hospitals	0.813	125.503	0.291	0.241	1.385	0.005
Generalist Hospitals	referent	referent	referent	referent	referent	-
Herfindahl-Hirschman Index	-0.092	-8.807	0.134	-0.356	0.171	0.492
Interaction between Surgical Profile and Herfindahl-Hirschman						
Specialist Hospitals * HHI	-0.649	-47.740	0.705	-0.203	0.734	0.357
No Focus Hospitals * HHI	0.267	30.658	0.682	-0.455	0.990	0.468
Cardiovascular Hospitals * HHI	0.254	28.919	0.409	-0.548	1.056	0.534
Low Surgical Volume Hospitals * HHI	0.496	64.242	0.350	-0.191	1.184	0.157
High Surgical Volume Hospitals * HHI	-0.140	-13.079	0.296	-0.721	0.441	0.636
Generalist Hospitals * HHI	referent	referent	referent	referent	referent	-
Hospitals in Urban Location	0.165	17.882	0.103	-0.037	0.366	0.109
Interaction between Surgical Profile and Urban Location						
Specialist Hospitals * Suburban/Rural Location	0.000	(empty)	(empty)			
Specialist Hospitals * Urban Location	0.000	(omitted)	(omitted)			
No Focus Hospitals * Urban Location	-0.366	-30.684	0.463	-1.275	0.542	0.429
Cardiovascular Focus Hospitals * Urban Locations	0.649	91.326	0.444	-0.223	1.520	0.144
Low Surgical Volume Hospitals * Urban Locations	-0.065	-6.290	0.463	-0.973	0.843	0.888
High Surgical Volume Hospital * Urban Location	-0.343	-29.026	0.248	-0.830	0.144	0.167
Generalist Hospitals * Urban Location	referent	referent	referent	referent	referent	-
Sample Size				772.000		
Adjusted R-Squared				0.792		
F Statistic				F (20, 742) = 102.29, p < 0.01		

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula (exp(β) – 1)*100

Note: The identical control covariates from the three original regression models were included in this regression model but for the sake of brevit these; control variables have been omitted from table

Table 12: Post-Hoc Estimations for Pairwise Comparisons of Interaction between Surgical Profile and Competition for 3-year Average Net Patient Revenue Annualized

Surgical Profile	Contrast	Reverse Transformed Coef. *	Std. Error	Bonferroni 95% Conf. Interval		P-value
No Focus versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Cardiovascular Focus versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Low Surgical Volume versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
High Surgical Volume versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Generalist versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Cardiovascular Focus versus No Focus Hospitals	-0.318	-27.233	0.174	-0.829	0.193	1.000
Low Surgical Volume versus No Focus Hospitals	-0.375	-31.269	0.184	-0.918	0.168	0.634
High Surgical Volume versus No Focus Hospitals	-0.408	-33.470	0.162	-0.886	0.071	0.185
Generalist versus No Focus Hospitals	-0.925	-60.343	0.135	-1.321	-0.529	p < 0.001
Low Surgical Volume versus Cardiovascular Focus Hospitals	-0.057	-5.548	0.188	-0.610	0.496	1.000
High Surgical Volume versus Cardiovascular Focus Hospitals	-0.090	-8.572	0.167	-0.581	0.402	1.000
Generalist versus Cardiovascular Focus Hospitals	-0.607	-45.502	0.134	-1.003	-0.211	p < 0.001
High Surgical Volume versus Low Surgical Volume Hospitals	-0.033	-3.202	0.178	-0.557	0.492	1.000
Generalist versus Low Surgical Volume Hospitals	-0.550	-42.301	0.150	-0.990	-0.110	0.004
Generalist versus High Surgical Volume Hospitals	-0.517	-40.393	0.122	-0.876	-0.159	p < 0.001

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula (exp(β) – 1)*100

Log Transformed Total Operating Expense Annualized and Surgical Profiles Moderated by Local Market Characteristics Regression Model

Hospitals in the Specialist class were omitted from moderation analysis due to a lack of variation in their geographic location, with all hospitals being located in urban markets. The second regression model accounted for about 80% of the variation between hospitals with respect to their 3-year average total operating expense annualized (adjusted $R^2 = .804$; Table 13). There was a .001 change in the R^2 for this model compared to the model without the interactions. There were no significant moderating influences for competition and location. Post-hoc comparison between all classes (Table 14) revealed four significant moderating influences when comparing the surgical profiles; Generalist versus No Focus; Generalist versus Cardiovascular Focus; Generalist versus Low Surgical Volume; and Generalist versus High Surgical Volume. Due to the very small change in the adjusted R^2, these differences do not point to notable moderating influences.

Table 13: 3-year Average Total Operating Expense Annualized Regression Results, Interaction between Surgical Profile and Competition

Log Transformed Total Operating Expense	Coef.	Reverse Transformed Coef. *	Std. Err.	95% Confidence Interval		P-value
Specialist Hospitals	1.025	178.667	0.166	0.699	1.351	p < 0.001
No Focus Hospitals	1.354	287.138	0.479	0.414	2.294	0.005
Cardiovascular Focus Hospitals	0.189	20.811	0.470	-0.733	1.111	0.688
Low Surgical Volume Hospitals	0.596	81.574	0.486	-0.358	1.551	0.220
High Surgical Volume Hospitals	0.862	136.892	0.283	0.306	1.419	0.002
Generalist Hospitals	referent	referent	referent	referent	referent	-
Herfindahl-Hirschman Index	-0.072	-6.964	0.131	-0.329	0.184	0.581
Interaction between Surgical Profile and Herfindahl-Hirschman Index						
Specialist Hospitals * HHI	-0.742	-52.385	0.685	-2.087	0.603	0.279
No Focus Hospitals * HHI	0.171	18.640	0.358	-0.532	0.874	0.633
Cardiovascular Hospitals * HHI	0.054	5.550	0.397	-0.726	0.834	0.892
Low Surgical Volume Hospitals * HHI	0.332	39.363	0.341	-0.337	1.001	0.330
High Surgical Volume Hospitals * HHI	-0.270	-23.656	0.288	-0.835	0.295	0.349
Generalist Hospitals * HHI	referent	referent	referent	referent	referent	-
Hospitals in Urban Location	0.175	19.097	0.100	-0.021	0.371	0.080
Interaction between Surgical Profile and Urban Location						
Specialist Hospitals * Suburban/Rural Location	0.000	(empty)	(empty)			
Specialist Hospitals * Urban Location	0.000	(omitted)	(omitted)			
No Focus Hospitals * Urban Location	-0.480	-38.120	0.450	-1.364	0.404	0.287
Cardiovascular Focus Hospitals * Urban Locations	0.551	73.571	0.432	-0.296	1.399	0.202
Low Surgical Volume Hospitals * Urban Locations	-0.069	-6.698	0.450	-0.953	0.814	0.878
High Surgical Volume Hospital * Urban Location	-0.362	-30.343	0.241	-0.835	0.112	0.134
Generalist Hospitals * Urban Location	referent	referent	referent	referent	referent	-
Sample Size				772.000		
Adjusted R-Squared				0.804		
F Statistic				F (20, 742) = 109.71, p < 0.01		

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula (exp(β) – 1)*100

Note: The identical control covariates from the three original regression models were included in this regression model but for the sake of brevit these; control variables have been omitted from table

Table 14: Post-Hoc Estimations for Pairwise Comparisons of Interaction between Surgical Profile and Competition for 3-year Average Total Operating Expenses Annualized

Surgical Profile	Contrast	Reverse Transformed Coef. *	Std. Error	Bonferroni 95% Conf. Interval		P-value
No Focus versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Cardiovascular Focus versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Low Surgical Volume versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
High Surgical Volume versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Generalist versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Cardiovascular Focus versus No Focus Hospitals	-0.275	-24.027	0.169	-0.772	0.222	1.000
Low Surgical Volume versus No Focus Hospitals	-0.403	-33.160	0.179	-0.931	0.125	0.374
High Surgical Volume versus No Focus Hospitals	-0.389	-32.230	0.158	-0.854	0.076	0.210
Generalist versus No Focus Hospitals	-0.940	-60.919	0.131	-1.325	-0.554	p < 0.001
Low Surgical Volume versus Cardiovascular Focus Hospitals	-0.128	-12.021	0.183	-0.666	0.410	1.000
High Surgical Volume versus Cardiovascular Focus Hospitals	-0.114	-10.798	0.162	-0.593	0.641	1.000
Generalist versus Cardiovascular Focus Hospitals	-0.665	-48.560	0.131	-1.050	-0.280	p < 0.001
High Surgical Volume versus Low Surgical Volume Hospitals	0.014	1.391	0.173	-0.495	0.524	1.000
Generalist versus Low Surgical Volume Hospitals	-0.537	-41.531	0.145	-0.965	-0.108	0.004
Generalist versus High Surgical Volume Hospitals	-0.550	-42.334	0.118	-0.899	-0.202	p < 0.001

*Coefficients reverse transformed for the purposes of interpretation utilizing the following formula (exp(β) – 1)*100

Average Operating Margin and Surgical Profile Moderated by Local Market Characteristics Regression Model

Hospitals in the Specialist class were omitted from moderation analysis due to a lack of variation in their geographic location, with all hospitals being located in urban markets. The third regression model accounted for slightly more than 10% of the variation between hospitals with respect to their 3-year average operating margin moderated by local market characteristics (adjusted $R^2 = .101$; Table 15). The post-hoc estimations for pairwise comparison (Table 16) show no statistically significant differences between any of the surgical profiles.

Table 15: Operating Margin Annualized Regression Results, Interaction between Surgical Profile and Competition

Operating Margin	Coef.	Std. Err.	95% Confidence Interval		P-value
Specialist Hospitals	0.054	0.066	-0.076	0.184	0.416
No Focus Hospitals	-0.155	0.192	-0.531	0.221	0.419
Cardiovascular Focus Hospitals	-0.164	0.188	-0.533	0.206	0.385
Low Surgical Volume Hospitals	0.057	0.195	-0.325	0.439	0.771
High Surgical Volume Hospitals	-0.061	0.113	-0.283	0.162	0.593
Generalist Hospitals					
Herfindahl-Hirschman Index	-0.019	0.052	-0.122	0.083	0.710
Interaction between Surgical Profile and Herfindahl-Hirschman Index					
Specialist Hospitals * HHI	0.083	0.274	-0.456	0.621	0.764
No Focus Hospitals * HHI	0.114	0.143	-0.167	0.954	0.427
Cardiovascular Hospitals * HHI	0.221	0.159	-0.091	0.534	0.164
Low Surgical Volume Hospitals * HHI	0.133	0.136	-0.134	0.401	0.328
High Surgical Volume Hospitals * HHI	0.134	0.115	-0.092	0.360	0.245
Generalist Hospitals * HHI	referent	referent	referent	referent	
Hospitals in Urban Location	-0.031	0.040	-0.109	0.048	0.442
Interaction between Surgical Profile and Urban Location					
Specialist Hospitals * Suburban/Rural Location	0.000	(empty)			
Specialist Hospitals * Urban Location	0.000	(omitted)			
No Focus Hospitals * Urban Location	0.139	0.180	-0.214	0.493	0.439
Cardiovascular Focus Hospitals * Urban Locations	0.099	0.173	-0.240	0.439	0.565
Low Surgical Volume Hospitals * Urban Locations	-0.038	0.180	-0.392	0.315	0.831
High Surgical Volume Hospital * Urban Location	0.027	0.097	-0.162	0.217	0.777
Generalist Hospitals * Urban Location	referent	referent	referent	referent	-
Sample Size			772		
Adjusted R-Squared			0.101		
F Statistic			F (20, 742) = 4.00, p < 0.01		

Note: The identical control covariates from the three original regression models were included in this regression model but for the sake of brevit these; control variables have been omitted from table

Table 16: Post-Hoc Estimations for Pairwise Comparisons of Interaction between Surgical Profile and Competition for Operating Margin Annualized

Surgical Profile	Contrast	Std. Error	Bonferroni 95% Conf. Interval		P-value
No Focus versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Cardiovascular Focus versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Low Surgical Volume versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
High Surgical Volume versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Generalist versus Specialist Hospitals	Not Estimable	Not Estimable	Not Estimable	Not Estimable	Not Estimable
Cardiovascular Focus versus No Focus Hospitals	-0.043	0.068	-0.242	0.156	1.000
Low Surgical Volume versus No Focus Hospitals	0.058	0.072	-0.153	0.269	1.000
High Surgical Volume versus No Focus Hospitals	-0.003	0.063	-0.189	0.184	1.000
Generalist versus No Focus Hospitals	0.045	0.052	-0.120	0.189	1.000
Low Surgical Volume versus Cardiovascular Focus Hospitals	0.101	0.073	-0.114	0.316	1.000
High Surgical Volume versus Cardiovascular Focus Hospitals	0.041	0.065	-0.151	0.232	1.000
Generalist versus Cardiovascular Focus Hospitals	0.078	0.052	-0.076	0.232	1.000
High Surgical Volume versus Low Surgical Volume Hospitals	-0.061	0.063	-0.265	0.144	1.000
Generalist versus Low Surgical Volume Hospitals	-0.023	0.058	-0.195	0.148	1.000
Generalist versus High Surgical Volume Hospitals	0.037	0.047	-0.102	0.177	1.000

Summary

The univariate results begin to shed light on the difference between classes and support the argument that hospitals differ in terms of their surgical profiles. The bivariate and multivariate results also identified statistically significant differences between hospitals with different surgical profiles and financial performance, although these differences were limited to net patient revenues and operating expenses and not operating margins. The analysis also suggests that these relationships are consistent across different market conditions (i.e., competition, urban vs. suburban/rural).

When looking at the univariate and bivariate results, the findings also suggest that hospitals within a surgical profile may share common structural attributes and operate in similar types of communities. Interestingly, the class of Specialist hospitals have the fewest hospitals yet the highest net patient revenue and expenses. Hospitals in the Specialist class may be typified by academic medical centers due to their urban location, large staffed bed size, and not-for-profit status. Notably, academic medical centers operate under a different payment model that tries to account for medical education by providing additional monies based on the number of residents per bed (MedPac, 2016), which may account for some of the differences in financial performance. The findings also suggest that hospitals in the Cardiovascular Focus class may be best thought of as cardiovascular specialty hospitals or community hospitals with cardiovascular designations due to the high volumes of cardiology, cardiovascular, and open heart surgeries found within hospitals belonging to this latent class. Hospitals in the Low Surgical Volume class are largely for-profit, which could also account for the high operating margins of the hospitals in this group given their focus on financial performance to meet shareholder demands. Small community hospitals in smaller markets seem to typify Generalist hospitals, which may contribute to their lower levels of net patient revenue and operating expense. Hospitals in this profile had the fewest staffed beds, on average, and the fewest urban hospitals. In contrast, hospitals in the No Focus and High Surgical Volume classes do not seem to share common characteristics or have an archetype that would best characterize their profiles. Instead, both of these profiles cover a wide range of hospitals with varying structural and community characteristics. Explanations for these findings and their implications for policy, practice, and future research will be discussed in the next chapter. Before doing so, it is worth noting some of the limitations of the study. First, there is the potential of misclassification of surgical codes to a surgical specialty due the use of only a single nurse to make this assignment. Although this nurse had extensive industry experience, the use of multiple rates and interrater reliabilities could have provided greater assurance of correct classification. Second, the study was limited to 3 states (Florida, New York, and California), and thus, may have limited external validity. Third, the study adopted a pooled, cross-sectional analytic strategy and assumed stability over the three years included in the study. Surgical profiles of hospitals, however, may change over time.

CHAPTER 5

DISCUSSION

Overview

Hospitals operate in turbulent and complex environments with limited resources. Therefore, administrators need to understand how to best use resources to improve and maximize performance. Surgical Services, in particular, is a key operational area for hospitals and a better understanding of how this department contributes to financial performance is important for leaders of hospitals. Given the importance of surgical services to a hospital's financial health, the purpose of this study was three-fold. First, the study identified different surgical profiles of hospitals based on the type and volume of surgical services provided by hospitals. Second, the study assessed whether these surgical profiles were associated with financial performance defined as net patient revenue, total operating expense, and operating margin. Third, the study examined the moderating effects of local market characteristics on the relationship between surgical profiles and financial performance. Administrators and surgical services leadership can use findings from this study to modify surgical services to best meet their needs, such as hiring necessary surgeon specialties or modifying (expanding, contracting) surgical service lines.

Surgical Profiles

Hospitals can be distinguished based on the types and volume of surgical procedures they perform, as evident in the surgical profiles identified in this study. The existence of different surgical profiles can assist administrators and policy makers in framing strategic discussions as well as policy decision making. For example, these profiles might shed light on differences found in previous research between hospitals with different structural attributes, such as specialty hospitals versus general hospitals, health systems versus independent hospitals, location, and size. Likewise, study findings may provide additional ways of thinking about competition within markets. For example, many studies assume most, if not all, hospitals in the same market are direct competitors by constructing measures of competition based on size (number of beds) or percentage of revenues. However, our findings suggest that hospitals that belong to different surgical profiles may only be indirect competitors and may even play complementary roles in a market.

Study findings might also allow administrators and surgical services management to modify their surgical operations to adopt an alternative surgical profile based on their needs. Alternative surgical profiles may provide better positioning for the organization within their market. Likewise, administrators may also want to alter their surgical profiles to better meet the needs of the community. The findings of this study suggest that administrators may be able to pursue such changes in their surgical profiles without negatively affecting their operating margin. Even so, such a shift in focus likely entails significant changes for a hospital and future research would be needed to identify the challenges and other (non-financial) costs of such a shift.

As for policy makers, the concept of surgical profiles expands the implications of enacting policies that may affect surgical operations. For instance, if reimbursement changed for general surgeries, the Generalist focus hospitals would see the largest effect from this policy change. Thus, reimbursement changes may not have a uniform effect on hospitals due to differences in their surgical profiles. Similarly, closures of hospitals or reductions in services by hospitals with different surgical profiles may not have a uniform impact on access to care. In sum, these findings are consistent with and reinforce other studies suggesting that ‘one size fits all’ policy approaches may have unintended consequences.

Financial Performance

The study found that net patient revenue and total operating expense varied significantly across the different surgical profiles, while operating margin did not. A closer examination of this pattern shows that because both net patient revenue and total operating expense differ in similar ways between the surgical profiles, they offset differences in operating margin. Moreover, it is notable that differences in operating margin do exist in the bivariate analysis, but disappear when other study characteristics are controlled for in the analysis.

One implication of this finding is that hospital administrators may have one less concern when considering changes to their surgical service offerings. For example, modifications to their surgical service offering in an effort to improve quality does not necessarily lead to negative effects on their bottom line. Likewise, to the extent changes in the policy environment create demands and opportunities for change in surgical services (e.g., reimbursement that favors certain procedures), administrators may be able to adapt without significant effects on their operating margin. That said, hospitals likely have fixed costs associated with certain surgical services that may prevent changes to its surgical service offering. Likewise, other factors (e.g., disruptions in service, access to service, staffing) must be considered when making such changes and may prevent quick changes to its surgical offering. Future research is needed to identify the challenges and consequences of changing a hospital's surgical profile.

The Moderating Influence of Local Market Characteristics on the Relationship between Surgical Profiles and Financial Performance

The study also considered the moderating effects of local market characteristics (urban/rural and competition) on the relationship between surgical profiles and financial performance. Results from the analysis showed that there were no statistically significant moderating influences of the local market characteristics considered in the study. One explanation could be that this relationship simply does not differ across different community types and differences between these classes of hospitals are consistent regardless of where they are located. It is also possible, however, that other characteristics – at the hospital level, community level, or even state level - may moderate this relationship. Still another explanation is related to a restriction in range for the moderating variables. That is, it could be that a relationship could not be detected due the sample having few suburban/rural hospitals and hospitals were all in relatively competitive markets.

Areas of Further Research

The findings of the study raise a number of questions that are worthy of future research. First, surgical profiles have not been established in previous research and more research is needed to understand these profiles. For example, are differences in profiles intentional/strategic or emergent over time? If intentional, what factors drive the decision to pursue one profile over another? What factors might cause a hospital to change profiles and what effect do such changes have on performance? Second, do different surgical profiles have implications for other areas of performance? For example, the study could be repeated utilizing quality measures (e.g., surgical site infections or readmissions) as the dependent variable(s). Likewise, patient experience may be another important outcome to consider. Third, a different sample with a larger range of market characteristics for the sample group could be collected to re-examine the moderating effects of local market characteristics on the relationship between hospital surgical profiles and financial performance. Additionally, other moderating characteristics might be considered (e.g., SES of community, patient mix).

Conclusion

Hospitals operate in turbulent and complex environments with limited resources. Consequently, administrators need to understand how to best use resources and improve a hospital's positioning in a market. Surgical Services is a key operational area for hospitals and a better understanding of how this department can be modified to meet the needs of organizations is important. This study found that hospitals differ in the types and volumes of procedures in predictable ways, yet these differences do not necessarily translate into a hospital's bottom line financial performance. From a practitioner perspective, the findings of the study point to new ways of thinking about managing the portfolio of surgical services offered at the organization. Surgical profiles might shed light on differences found in previous research between hospitals with different structural attributes, such as specialty hospitals versus general hospitals, health systems versus independent hospitals, location, and size. From a policy standpoint the findings of this study suggest uniform approaches to treating hospitals with respect to surgical profiles and payment systems may be misguided.

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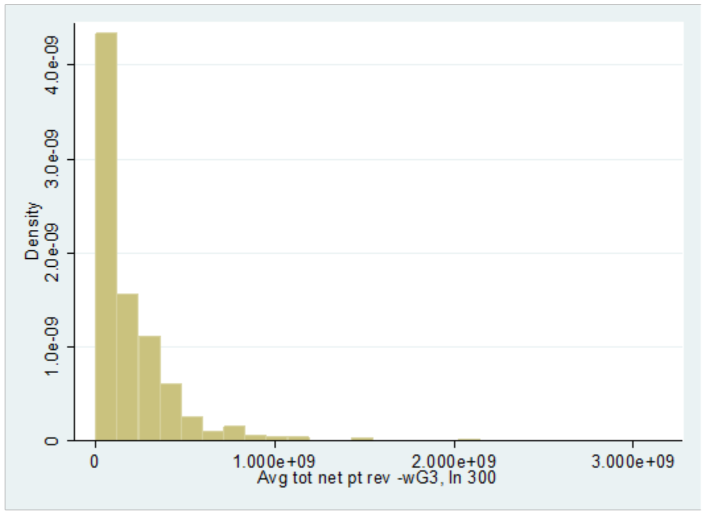
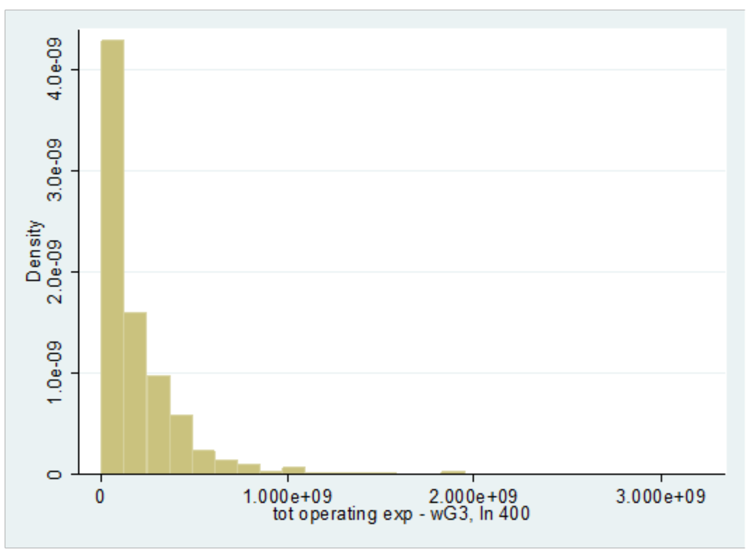
APPENDIX A

DEPENDENT VARIABLE HISTOGRAMS

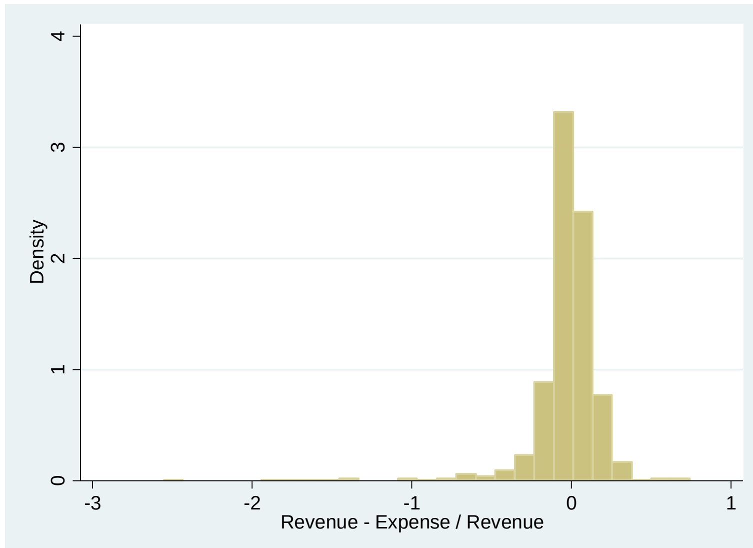
Histogram of Net Patient Revenue



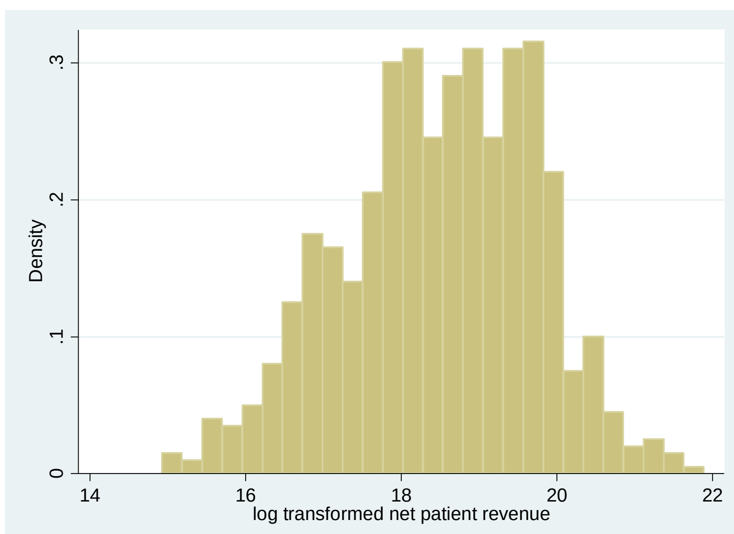
Histogram of Total Operating Expense



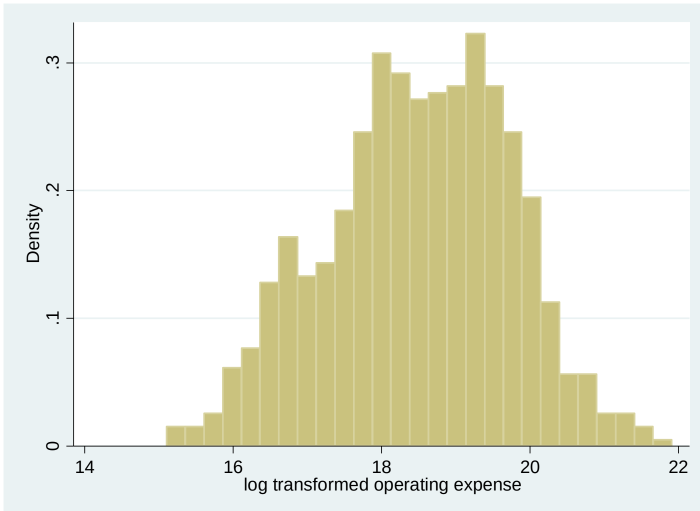
Histogram of Operating Margin



Histogram of Log Transformed Net Patient Revenue



Histogram of Log Transformed Total Operating Expense



APPENDIX B

UAB IRB APPROVAL

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

Exemption Designation
Identification and Certification of Research
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on January 24, 2017. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56.

Principal Investigator:	HIGMAN, LUCAS
Co-Investigator(s):	CARROLL, NATHANIEL W. O'CONNOR, STEPHEN J
Protocol Number:	**E160406002**
Protocol Title:	*Examining the Relationship Between Surgical Profiles and Financial Performance of Hospitals*

The above project was reviewed on 4/20/16. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This project qualifies as an exemption as defined in 45CFR46.101(b), paragraph 4.

This project received EXEMPT review.

Date IRB Designation Issued: 4/20/16

Nancy D. Stansfield CIP
Designated Reviewer
Chair Designee

Investigators please note:

Any modifications in the study methodology, protocol and/or consent form/information sheet must be submitted for review to the IRB prior to implementation.