

ESSAYS IN HEALTHCARE QUALITY AND EFFICIENCY:  
AN OPERATIONS MANAGEMENT EXAMINATION

by

Scott Hixson Lindsey

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STATEMENT OF DISSERTATION APPROVAL

The dissertation of Scott Hixson Lindsey

has been approved by the following supervisory committee members:

<u>Jeff K. Stratman</u>	, Chair	<u>Nov. 4, 2011</u> <small>Date Approved</small>
<u>Glen Schmidt</u>	, Member	<u>Nov. 4, 2011</u> <small>Date Approved</small>
<u>Don G. Wardell</u>	, Member	<u>Nov. 4, 2011</u> <small>Date Approved</small>
<u>Sriram Thirumalai</u>	, Member	<u>Nov. 4, 2011</u> <small>Date Approved</small>
<u>Karin Fladmoe-Lindquist</u>	, Member	<u>Nov. 4, 2011</u> <small>Date Approved</small>

and by Don G. Wardell, Chair of the Department of Operations and Information Systems

and by Charles A. Wight, Dean of The Graduate School.

## ABSTRACT

U.S. healthcare costs have shown a marked increase as a percentage of GDP over the past decades. Additionally, the growth of U.S. healthcare spending is outpacing that of other industrialized economies. With this rapid pace of growth and spending, explorations of quality and efficiency within the U.S. healthcare system find a prominent place within the academy.

This dissertation adds to extant research via three essays, each exploring unique dimensions of healthcare quality and efficiency. The first essay, *Drivers of Quality and Efficiency: A Healthcare Perspective*, utilizes regression and stochastic frontier analysis to explore drivers of hospital outcome quality and efficiency. Secondary source data from over 1,800 U.S. hospitals are used to evaluate the degree to which process standardization, service effectiveness and operational focus drive outcome quality and efficiency. In support of hypotheses and extant operations management theory, process standardization is found to relate positively to both outcome quality and efficiency while service effectiveness relates positively to outcome quality but is negatively related to efficiency. Contrary to hypotheses and theory, lower levels of operational focus (i.e., wider breadth of services) are found to positively contribute to outcome quality and efficiency.

The second essay, *Healthcare Focus and Performance: A Multidimensional Exploration*, further explores the unexpected focus / performance relationship of the first

essay. Using extant research and the data set from the first essay, multidimensional measures of both hospital focus and performance are proposed and evaluated utilizing canonical correlation analysis. This essay provides a contribution by evaluating rigorous multidimensional measures of both focus and performance and confirming that hospitals exhibiting a broader range of services also provide higher levels of overall performance. Additional insights are provided by evaluating individual indicators of focus and exploring their relative contributions to performance.

The third essay, *Competitive Capabilities: A Healthcare Perspective*, examines the acquisition of quality and efficiency capabilities in light of Competitive Progression and Trade-off theoretical frameworks. Panel data from over 140 California hospitals from two time frames (2005-2008, and 2006-2009) and statistical differencing techniques are utilized to find support for the Competitive Progression framework for hospitals residing well off an economic performance frontier.

## CONTENTS

ABSTRACT.....	iii
LIST OF FIGURES.....	vii
ACKNOWLEDGEMENTS.....	viii
1. DRIVERS OF QUALITY AND EFFICIENCY: A HEALTHCARE PERSPECTIVE.1	
1.1.    Introduction .....	1
1.2.    Literature Review .....	3
1.2.1. Quality in Healthcare .....	3
1.2.2. Healthcare Efficiency .....	5
1.3.    Conceptual Development .....	6
1.3.1. Outcome Quality .....	6
1.3.2. Efficiency .....	12
1.4.    Data Sources and Measures .....	16
1.4.1. Data Sources.....	16
1.4.2. Measures.....	18
1.5.    Analysis and Results.....	25
1.5.1. Drivers of Quality (H1, H2, H3) .....	25
1.5.2. Drivers of Efficiency (H4 - H7) .....	28
1.6.    Discussion.....	31
1.7.    Conclusions and Limitations .....	36
1.8.    Appendix A – Risk-adjusted Mortality and Readmission .....	38
1.9.    Appendix B - Supplemental Analysis .....	40
1.9.1. Results Summary.....	40
1.9.2. Min – Max Analysis.....	41
1.9.3. Multidimensional Analysis .....	44
1.9.4. Quantile Analysis .....	47
1.9.5. Conclusion.....	53
1.10.   References .....	54
2. HEALTHCARE FOCUS AND PERFORMANCE: A MULTIDIMENSIONAL EXPLORATION.....	61
2.1.    Introduction .....	61
2.2.    Literature Review .....	64

2.2.1.	Evolution of Concept of Factory Focus .....	65
2.2.2.	Focus and Performance .....	67
2.2.3.	Quality Contribution to Performance .....	70
2.3.	Conceptual Development .....	71
2.3.1.	Measures of Service Focus.....	71
2.3.2.	Measures of Hospital Performance .....	76
2.4.	Data Sources and Measures.....	83
2.4.1.	Data Sources.....	83
2.4.2.	Measures.....	87
2.4.3.	Measure Summary.....	94
2.5.	Analysis and Results.....	95
2.5.1.	Hospital Focus and Hospital Performance .....	97
2.6.	Discussion.....	103
2.7.	Conclusions and Limitations .....	110
2.8.	Appendix A - Risk-adjusted Mortality and Readmission.....	112
2.9.	Appendix B – Supplemental Analyses .....	114
2.10.	References .....	121
3. COMPETITIVE CAPABILITIES: A HEALTHCARE PERSPECTIVE.....		127
3.1.	Introduction .....	127
3.2.	Literature Review .....	130
3.2.1.	Capability Trade-off Theory .....	130
3.2.2.	Competitive Progression Theory (CPT).....	132
3.2.3.	Linkages Between Trade-off and Competitive Progression Theories.....	135
3.3.	Conceptual Development .....	136
3.3.1.	Choice of Competitive Priorities.....	137
3.3.2.	Performance Frontiers .....	138
3.3.3.	Integrating Performance Frontiers and Competitive Capabilities.	139
3.4.	Data Sources and Measures .....	144
3.4.1.	Data Sources.....	144
3.4.2.	Measures.....	148
3.5.	Analysis and Results.....	155
3.5.1.	Cluster Analysis .....	156
3.5.2.	Dependent Variable Measurement Invariance .....	159
3.5.3.	Hypothesis Testing.....	161
3.6.	Discussion.....	170
3.6.1.	Competitive Progression Theory – Parallel Form.....	170
3.6.2.	Competitive Capability Trade-off.....	172
3.7.	Conclusions and Limitations .....	172
3.8.	Appendix – Risk-adjusted Mortality and Readmission.....	174
3.9.	References .....	176

## LIST OF FIGURES

1.1. Drivers of Outcome Quality.....	12
1.2. Drivers of Efficiency.....	16
1.3. Outcome Quality Drivers – Upper and Lower 10%.....	42
1.4. Efficiency Drivers – Upper and Lower 10%.....	43
1.5 Outcome Quality Quantile Regression Summary.....	49
1.6. Efficiency Quantile Regression Summary.....	52
2.1. Hospital Focus / Performance Relationship.....	70
2.2. Hospital Focus – Conceptual Model.....	76
2.3. Hospital Performance – Conceptual Model.....	78
2.4. Hospital Focus and Performance – Full Conceptual Model.....	80
2.5. Canonical Correlation (CCA) Model for Focus – Performance Relationship.....	98
3.1. Integrative Capability Frontier Model.....	141
3.2. Cluster Centroids.....	158



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When considering the totality of experiences during the pursuit of a PhD, my recollection often turns to the title of a Grateful Dead album from the mid 1970s, “what a long strange trip it’s been”! Like most of life’s experiences, this “trip” has not been a solitary effort.

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## CHAPTER 1

### DRIVERS OF QUALITY AND EFFICIENCY: A HEALTHCARE PERSPECTIVE

#### 1.1. Introduction

Research into various healthcare topics is becoming prevalent within Operations Management. Much of this research has placed healthcare operations firmly within the purview of service operations (Chase & Apte, 2007; Karmarkar & Pitbladdo, 1995; Mersha, 1990). Application of strategic operations management to healthcare has also been researched (Butler et al., 1996; Li et al., 2002; Ward et al., 1995). A large portion of this research has been devoted to various aspects of quality and performance within the healthcare environment (Chesteen et al., 2005; Gowen et al., 2006; Meyer & Collier, 2001). This study expands on that portion of operations management research specifically relating to healthcare quality and performance.

Over the past 40 years, U.S. healthcare spending as a percentage of GDP has shown a steady and marked increase. Total U.S. healthcare spending during 1970 reached \$75 billion, or 7.2% of GDP. Spending in 2009 reached \$2.5 trillion or 17.6% of GDP. This represents a 144% increase in total healthcare spending in relation to the total output of the U.S. economy within a span of almost 40 years. It is projected that 2018 healthcare spending in the U.S. will approach \$4.3 trillion or 20.3% of GDP (Kaiser Family Foundation, 2009).

Further, U.S. per capita healthcare spending seems to be outpacing that of other industrialized economies. U.S. per capita healthcare spending in 2008 was estimated at \$7,290. This spending was almost double that of the next highest country in the sample. U.S. spending was also almost 6% higher as a percent of GDP, compared to the next highest sample country's spending (Organization for Economic Cooperation and Development, 2009).

With this increasing spending, mortality rates (a common measure of healthcare outcome quality) have not exhibited a corresponding decrease. In 1980, the U.S. exhibited a mortality rate of 8.7 deaths per 1,000. During 2005, this mortality rate decreased to approximately 8.2 (Department of Health and Human Services, 2007). These data reveal a disparity between healthcare quality and cost increases within the U.S. healthcare system. As cost and efficiency have been equated and interchanged within the healthcare literature (Carey, 2003; Vitaliano & Toren, 1994), a purpose of this study is to evaluate the drivers of healthcare outcome quality and efficiency and to explore the relationship between these two measures.

This study's contribution therefore is threefold:

- To provide an empirical analysis of healthcare outcome quality / efficiency drivers.
- To explore interrelationships between healthcare outcome quality and efficiency.

The technical efficiency of hospitals included within the study will be empirically estimated and the relationships between outcome quality to this efficiency estimate will be explored.

- To suggest operations management insights for developing quality and efficiency competencies within healthcare.

The remainder of this study is organized as follows: Section 2 provides a review of the literature, Section 3 conceptually develops the proposed hypotheses, Section 4 summarizes data sources and measures used within the study, Section 5 provides a summary of the empirical analyses and results, Section 6 presents a discussion of the results and Section 7 provides conclusions and an overview of future directions for this research stream.

## 1.2. Literature Review

There is a large body of literature in operations, strategy and healthcare pertaining to efficiency and quality. The literature review which follows for this study focuses primarily on topics pertaining to the Operations / Healthcare interface. This interface is defined within studies focusing on and juxtaposing definitions of quality and efficiency provided within the Operations and Healthcare literatures .

### 1.2.1. Quality in Healthcare

The Operations and Healthcare literatures provide several definitions of quality within the healthcare setting. The Operations literature addresses what can be referred to as “Process Quality” while the Healthcare literature focuses on “Clinical Quality.” It is becoming more apparent to both healthcare practitioners and operations researchers that both fields have much to offer each other in terms of quality and cost management (Pronovost & Boyer, 2010). This section provides a summary of these definitions and

identifies a further definition of outcome-based quality, which will be used as a key dependent variable within this study.

*Clinical quality* (best medical practices) and *process quality* (best operational practices) have both been found to be important in predicting patient satisfaction within the healthcare setting (Marley et al., 2004). Clinical quality has been identified to be primarily associated with practitioner performance, while process quality has been associated with administrator and staff performance. Quantitative (cost saving) and qualitative (error reduction) quality, both measures of process quality have also been shown to be positively related to hospital employee commitment and control initiatives (Gowen et al., 2006).

Clinical quality has been defined as “the quality of care as measured by information about the results of patient diagnosis and treatment (e.g., length of stay, infection rates)” (Li & Collier, 2000, p. 207). This definition provides focus on best medical practices relating to patient diagnosis. For the purposes of this study, clinical quality relates to the degree to which healthcare practitioners follow best medical practices in treating and diagnosing their patients.

Another common definition of healthcare quality relates to *outcome measures*. Outcome measures are most frequently defined in terms of mortality / morbidity rates within a given facility (Chung & Shauver, 2010; Spertus et al., 2003). Outcome-based measures have been the focus of several studies. Within nursing homes, no direct link between outcome quality and profit versus not-for-profit status has been identified (Chesteen et al., 2005). Outcome quality has also been studied in conjunction with the focus of a hospital unit. Focus in this case refers to a healthcare facility’s adoption of

workflows similar to those found in cellular manufacturing and plant-within-a-plant orientations. Little relationship was found to exist between outcome quality (a key performance measure) and focus (Hyer et al., 2009).

Some studies have provided insights on how these definitions of quality might be combined and researched in a holistic fashion. Tucker (2004) studied the impact of operational failures (operational quality) and organizational learning on quality of care in healthcare. Quality of care was defined in terms of nurses' ability to follow best practices in the presence of supply chain and staffing limitations. Quality of care in this context is closely related to this study's definition of clinical quality. In studying quality differentials between for-profit versus not-for-profit nursing homes Chesteen et al. (2005) discovered no direct link. Outcome quality (patient census health levels) was linked to profit status via two intermediate variables, process and input quality. Process quality was measured using the Baldrige award healthcare practice criteria. Input quality was defined as the overall degree of patient disability.

Employing the above definitions of healthcare quality and utilizing the approach suggested by previous research, this study utilizes outcome quality as the primary measure of quality. Operationalizations of clinical and operational quality will be evaluated for their individual effects upon outcome quality and are treated as individual drivers of outcome quality within this research.

### 1.2.2. Healthcare Efficiency

A relationship between outcome quality and costs / efficiency is suggested by data from the U.S. healthcare system presented above. However, there is limited research concerning efficiency in healthcare in the operations literature and how it might relate to

quality. A key contribution of this study is to provide additional insights to the seemingly little-researched quality / efficiency relationship within the healthcare setting.

It has been suggested that quality and efficiency are at odds within the healthcare setting due to the increased resources required to achieve increased outcome quality levels (Roland, 1999). Studies have found varying relationships between quality and efficiency. Poor quality has been associated with technical efficiency at Finnish hospitals and residential homes (Laine et al., 2005). Conversely, efficient hospitals have been found to perform well on process quality measures (Nayar & Ozcan, 2008). The paucity of literature exploring quality / efficiency relationships and these seemingly contradictory results provides motivation for further study of efficiency within healthcare which will be addressed by this study.

### 1.3. Conceptual Development

As shown in the literature review, there is a body of operations management and healthcare literatures evaluating outcome quality and efficiency and individual drivers of each. However, there is a lack of literature that addresses these drivers in an integrated fashion, examining a set of proposed drivers on both quality and efficiency. This section provides definition to quality, efficiency, and the proposed drivers selected for this study. Additionally, theoretical underpinnings for the hypothesized interrelationships between these constructs are provided.

#### 1.3.1. Outcome Quality

As noted previously, the dependent variable for quality within this study is the outcome of care provided at individual hospitals (Chung & Shauver, 2010). These

outcomes consist of mortality and readmission rates (Spertus et al., 2003) at hospitals included within the study. While there are many domains of quality within hospitals (e.g., outcome, process, organizational, etc.) (Rubin et al., 2001), outcome measures are particularly appropriate for a study of this type due to their close association with traditional operations management measures of quality including failure rates (mortality) and rework rates (readmission). The healthcare literature also frequently uses outcome measures as indicators of quality (Davies & Crombie, 1995; Isaac & Jha, 2008). Outcome quality, measured by mortality and readmission rates, forms the basis for evaluating quality throughout this study. The measure for outcome quality incorporates statistical risk-adjustment techniques which adjust for case mix and individual hospital differences. This risk-adjustment is defined in Appendix A. All hypothesized drivers of outcome quality relate back to this outcome-based quality.

The individual drivers of outcome quality identified within this study are;

- Process Standardization (the operationalization of Clinical Quality)
- Service Effectiveness (the operationalization of Operational Quality)
- Operational Focus

The inclusion of these drivers is suggested by prior operations literature pertaining to healthcare. Tucker (2004), Chesteen et al., (2005) and Hyer et al., (2009) each provided justification for the inclusion of the above measures as drivers of outcome quality.

#### 1.3.1.1. Outcome Quality and Process Standardization

Process standardization refers to the degree to which an individual hospital conforms to established clinical practice guidelines for a specific condition and is the



study's operationalization of Clinical Quality. Within an operations management context, this standardization relates to process variation reduction across products or customers (Frei et al., 1999). Reduction in this process variation (process standardization) has been shown to have beneficial relationships to quality. McLaughlin (1996) showed that eliminating high degrees of variation in a process is a necessary but not sufficient condition to providing quality services at reasonable cost. Within a manufacturing context, improvement in quality has been shown to be linked to effective process management or standardization (Ahire & Dreyfus, 2000).

While certainly not the sole determinant, process standardization has a prominent position within the literature in affecting outcome quality. Healthcare practitioners and the popular press also recognize the relationship between outcome quality and process standardization. Dr. Brent James, the Chief Quality Officer at Intermountain Healthcare, a recognized expert in healthcare quality and vocal proponent of standardization of healthcare delivery, has said that, "it's more important that you (doctors) do it the same way than what you think is the right way" (NYT, Nov. 8, 2009). A recent medical publication has put it this way, "Doctors have permission to forget. You have permission to be human and make mistakes, but you don't have permission to needlessly put patients at risk" (Medill Reports, April 28, 2010). Some practitioners have gone so far as to state that, "...lack of standardization is entirely unacceptable and dangerous to patients..." (Pronovost & Vohr, 2010, pp. 18-19). The fact that thought-leaders in healthcare quality feel the need to highlight the need for process standardization suggests that individual practitioners feel inclined to follow more individualized practice guidelines. Indeed, there is a "myth of perfection" that enshrouds doctors when determining their individual

approaches to treatment (Medill Reports, April 28, 2010). Practitioners rarely have “bosses” dictating treatment modalities. These practitioners also are often reluctant to have practitioners outside their individual specialties provide clinical practice guidelines.

Recognizing the conflict that often exists between individual practitioners and those professionals wishing to implement standardized treatment methodologies, the following hypothesis will be tested:

HYPOTHESIS 1. *Process standardization is positively related to outcome quality.*

#### 1.3.1.2. Outcome Quality and Service Effectiveness

Service effectiveness can be thought of as the degree to which the hospital provides patient care services which meet the expectations of the patient and hospital administration. This measure is the operationalization of Operational Quality. While process standardization relates to clinical practice guidelines in treating a given condition, service effectiveness is equated to norms of operational practice. Service effectiveness has been shown to have positive effects on outcome quality. As hospital and healthcare operations are a specific type of service operations, relationships found within other service industries should directly translate to the healthcare industry. Customers exposed to a service-oriented firm’s operations will develop a level of satisfaction, based on the firm’s specific performance, relative to these operational practices. The operations literature often refers to service effectiveness as process variation when evaluating its relation to quality outcomes. This stems partly from the fact that many studies are primarily concerned with evaluating service effectiveness and its relation to quality. Within the airline industry (a service industry) consistent enhancements in service effectiveness have been shown to be positively related to customer satisfaction, a

measure of outcome quality within a service industry (Tsikriktsis & Heineke, 2004). Also, within the real estate industry, another service-centric industry, customer satisfaction has been shown to be closely related to outcome quality (Dabholkar & Overby, 2005). Specifically within the healthcare industry, evidence of a positive relationship between patient satisfaction and clinical, i.e., healthcare, quality has been shown to exist (Marley et al., 2004). For these reasons, it is hypothesized that:

HYPOTHESIS 2. *Service effectiveness is positively associated with outcome quality.*

#### 1.3.1.3. Outcome Quality and Operational Focus

Another hypothesized driver of outcome quality, operational focus, is defined as the range or scope of services offered within the hospital. Individual hospitals often exhibit clinical competencies based either on the population served or on the specific strategic direction dictated by hospital management. Therefore, individual hospitals will often exhibit varying levels of care or procedural breadth.

This operational focus can be thought of in terms of a continuum. One extreme is occupied by specialty hospitals which, by design, focus on a narrow range of services. The other extreme would represent hospitals which offer as wide a range of services as possible, taking local needs and resources into account. An example of specialty hospitals is Shouldice Hospital, located in Ontario, Canada. This hospital is designed to provide a range of services focused on external abdominal wall hernia surgery. Other specialty hospitals might focus on respiratory care, orthopedic services, and/or long-term acute care. As the range of services in this type of healthcare facility is so narrowly focused, one would expect higher levels of quality and efficiency. The evaluation of focus as a driver of outcome quality envisioned in this study pertains to hospitals

providing a relatively wider range of services and can therefore be extended to a much larger sample of healthcare facilities.

This operational focus is closely related to the factory focus construct found within the operations management literature (Anderson, 1995; Bozarth & Edwards, 1997; Brush & Karnani, 1996; Hayes & Wheelwright, 1984; Ketokivi & Jokinen, 2006; Mukherjee et al., 2000; Pesch & Schroeder, 1996; Schmenner & Swink, 1998; Skinner, 1974). Within this literature it has been shown that the focused factory in a manufacturing environment consistently exhibits higher degrees of overall performance and product quality. This has been attributed to a phenomenon where the focused factory can concentrate on a reduced number of products or product lines, thereby enhancing performance and/or quality. This virtual reduction in product lines through organizational or physical division is often referred to as the “plant-within-a-plant” (Skinner, 1974).

Within the confines of this study, hospitals exhibiting narrower operational focus should be in a position to provide concentrated care and therefore be able to attain higher levels of outcome quality. Narrower operational focus translates into fewer customer groups (product lines). Based on this discussion:

*HYPOTHESIS 3. Operational focus is positively associated with outcome quality.*

Figure 1.1 shows the hypothesized relationships of the drivers of outcome quality.

It has been shown earlier that both quality and efficiency are relevant in evaluating the performance of individual healthcare facilities. However, no theoretical direction is provided as to the order in which quality or efficiency should be pursued as competitive priorities. Prior research has suggested that a progression exists among

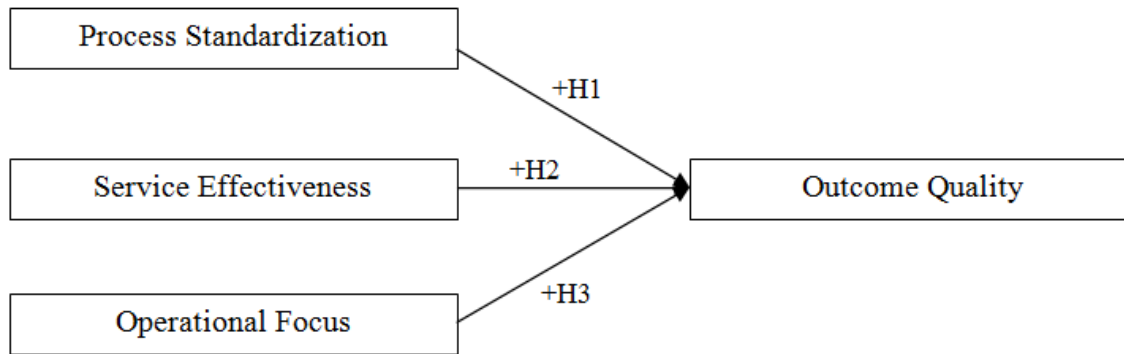


Figure 1.1: Drivers of Outcome Quality

competitive capabilities in pursuing performance enhancements. This prior research is framed in terms of an optimal progression of competitive capabilities which lead to enhanced performance outcomes (Ferdows & DeMeyer, 1990; Rosenzweig & Roth, 2004). These competitive priorities include both quality and low cost (efficiency). As noted previously, cost and efficiency have been equated and interchanged within the healthcare literature (Carey, 2003; Vitaliano & Toren, 1994). Using this framing of competitive priorities as a research framework we have previously explored healthcare quality and its drivers. We will next explore efficiency (low cost) and its drivers, including quality as a key driver of efficiency, which is consistent with the competitive progression theoretical framework suggested by prior research.

What follows is a discussion of the theoretical underpinnings of the drivers of healthcare quality and efficiency.

### 1.3.2. Efficiency

We now turn our focus to developing theoretical relationships between efficiency and those drivers of outcome quality described above. Additionally, we investigate the relationship between outcome quality and efficiency.

Efficiency, as defined within this study, relies on the concept of technical efficiency (Kumbhakar & Lovell 2000; Mishra et al., 2009). This technical efficiency is the relationship of observed productive output to maximum productive output. For any set of productive inputs, there exists a theoretical maximum or productive output frontier. The extent to which a firm, i.e., hospital, approaches this frontier is an indication of its technical efficiency.

Technical efficiency estimation is a common econometric measure used in studies of efficiency in a wide range of disciplines. Reinhard et al. (2000) utilized technical efficiency measures in studying comprehensive environmental efficiency measures for Dutch dairy farms. Technical efficiency is also utilized to study the relationship between German hospital efficiency and “ownership, patient structure, and other exogenous factors, which are neither inputs to nor outputs of the production process” (Herr, 2008, Abstract). Also, technical efficiency is recognized as a valid measure in ranking hospitals in terms of overall efficiency (Jacobs, 2001).

#### 1.3.2.1. Efficiency and Process Standardization

Within manufacturing environments, process standardization has been shown to provide improvements in efficiency (Kumar & Harms, 2004). Standardizing business processes is also common to healthcare, software, manufacturing, and service industries (Devaraj & Kohli, 2000). A significant motivation for pursuing business process standardization is to achieve efficiency gains necessary to remain competitive in a rapidly changing environment. For these and reasons similar to those posited in relating Outcome Quality with Process Standardization, it is hypothesized that:

*HYPOTHESIS 4. Process standardization is positively associated with efficiency.*

### 1.3.2.2. Efficiency and Service Effectiveness

Outcome quality is hypothesized to be positively related to service effectiveness. This positive relationship is hypothesized to exist due to service operations arguments of enhanced customer satisfaction (an outcome quality measure) resulting from standardized service encounters.

Evaluating the differential effect of superior (or inferior) combinations of resource inputs on the efficiency between distribution systems, Ross and Droge (2004) hypothesize that efficiency differences may result. It has been shown that service effectiveness execution and improvement require a significant investment in human resources (Karwan & Markland, 2006). Holding other inputs to the production function constant, this additional resource investment will exhibit itself with a net decrease in overall institutional efficiency. This leads to a hypothesized service effectiveness / efficiency relationship which differs from that of the outcome quality / service effectiveness relationship, namely;

*HYPOTHESIS 5. Service effectiveness is negatively associated with efficiency.*

### 1.3.2.3. Efficiency and Operational Focus

Efficiency and factory focus, i.e., operational focus, have also been studied within the operations management literature. As factories exhibiting a higher degree of focus produce fewer lines of product, setup times to change production from one line to another are reduced. This reduction in setup times has been shown to yield enhanced efficiencies (Ketokivi & Jokinen, 2006).

For the same reasons noted in the discussion for Hypothesis 3, Operational Focus's relationship to efficiency in this study relates most to nonspecialty hospitals. Nonspecialty (general) hospitals require higher levels of set-up in that these facilities offer a wider range of services (nonfocus). Therefore, one would expect to see higher degrees of efficiency in specialty hospitals in relation to general hospitals.

While not specifically demonstrated within the healthcare context, it has been hypothesized that focused care in hospitals could lead to efficiencies found in other sectors of the U.S. economy (Herzlinger, 1998). This relationship would hold for the same reason that it would within the manufacturing sector. Fewer product lines (patient care domains) lead to a reduction in the number of disparate procedures being performed which will translate to enhanced efficiencies. For these reasons:

*HYPOTHESIS 6. Operational focus is positively associated with efficiency.*

#### 1.3.2.4. Efficiency and Outcome Quality

The association between efficiency and quality in healthcare is one of the central contributions of this research. Extant research shows a range of results in describing this relationship.

Research centering on long-term elderly care facilities has shown no association between technical efficiency and quality of care (Laine et al., 2005). This research is particularly relevant to this study in that stochastic frontier analysis was utilized to empirically study the quality / efficiency relationship. Studying Virginia hospitals, Nayar and Ozcan (2008) found that both technically efficient and inefficient hospitals performed well with regard to quality measures.



Some of the operations management literature speaks of a trade-off existing between competitive priorities in manufacturing environments (Babu & Suresh, 1996; Pinker & Shumsky, 2000). Boyer and Lewis (2002) evaluated trade-offs between quality, cost, flexibility, and delivery competitive priorities. Their research found that manufacturing firms do make trade-offs between these priorities. In that quality and efficiency can be viewed as competitive priorities within the healthcare environment, we posit that hospitals will need to exhibit this trade-off behavior in pursuing quality and/ or efficiency. This trade-off phenomenon will lead to the final hypothesis within this study: *HYPOTHESIS 7. Outcome quality is negatively related to efficiency.*

Figure 1.2 shows the hypothesized relationships of the drivers of efficiency.

#### 1.4. Data Sources and Measures

##### 1.4.1. Data Sources

Data for the study are derived from two secondary sources;

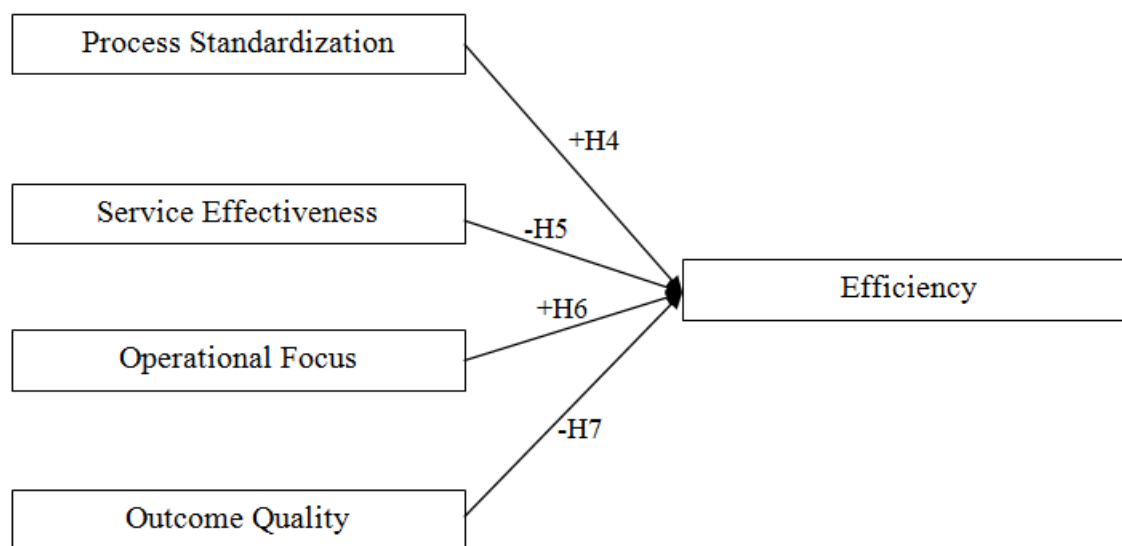


Figure 1.2: Drivers of Efficiency

- The U.S. Department of Health and Human Services Hospital Compare Database 2005 – 2008 (HCD)
- The State of California Office of Statewide Planning and Development Annual Financial Data 2008 (OSHPD).

The HCD provides hospital-provided and patient survey data on how well U.S. hospitals care for patients with a variety of medical conditions. Hospitals voluntarily agree to make this hospital-level data available. The database is designed to allow healthcare consumers a means by which they can evaluate the quality of care at hospitals they are considering for the provision of care. Additionally, the contents of the database, updated quarterly, are available for public download and are intended for use by healthcare researchers and policymakers.

The HCD is used to derive the following sets of measures; Outcome quality, Process Standardization, Service Effectiveness, and Operational Focus. Individual HCD data sets are reported by HHS each year (2005-2006, 2006-2007, 2007-2008) for the July – June timeframe. Data were combined to a single 2005-2008 HCD dataset to achieve consistency in reporting each of the measures described above. Mortality and readmission rates are reported for the 3-year 2005-2008 timeframe. To maintain consistency of data, other process and service measures were combined to mirror the same timeframe as reported within the mortality / readmission data. Complete measures exist for 1,832 U.S. hospitals.

The OSHPD is designed to provide public access to data on California healthcare facilities' infrastructure, outcomes, finances, safety, and capacity. These data are

provided to allow residents, researchers, and policymakers access to data on which they can rely.

The OSHPD contains detailed production and financial data used in developing efficiency measures. Measures used within this study include the number of discharges, the number of hospital full time equivalents, net property, plant and equivalents, and the number of beds and bassinets. Supplemental financial analysis utilizes net operating income. Data for a total of 152 California hospitals are utilized within this study.

#### 1.4.2. Measures

##### 1.4.2.1. Outcome Quality

Outcome quality scores for each hospital within HCD are reported and aggregated within this study. Thirty-day risk-standardized mortality and readmission rates for each condition at each hospital are summed to create an outcome quality score for each of the three conditions (heart attack, heart failure, and pneumonia) included in the study. While data are available for other conditions, these three conditions were specifically selected due to the prevalence of these conditions within the general population. This prevalence provides a robust data set which provides the data breadth and depth required for a study of this type. These combined scores are then averaged to create an overall outcome quality score for individual hospitals. This overall outcome quality score is then used as the dependent variable of outcome quality within the subsequent analysis. It should be noted that low to high mortality and readmission rates are equated with high to low outcome quality measures.

Risk-standardized mortality and readmission rates are often used as indicators when studying outcome quality. (Davies & Crombie, 1995; Krumholz et al., 2006;

Krumholz & Normand, 2008; Morley et al., 1992) This risk-standardized methodology overcomes a common critique of using outcome measures as a proxy for quality, namely that their interpretation is dependent upon the case mix and other hospital specific variables. Risk-standardized outcome measures specifically overcome this limitation and provide a robust proxy for hospital outcome quality.

A hierarchical regression model is utilized to compute hospital-specific 30-day readmission rates. (Note: This hierarchical regression is not part of this study. Data within the dataset have already been subjected to this regression.) Specific patient-level factors considered in determining the risk-standardized mortality and readmission rates include; gender, existing comorbidities, and past medical history Specific hospital level factors utilized in determining the risk-standardized mortality and readmission rates include the unique quality of care for all patients treated for that condition in that hospital. Appendix A contains a more detailed description of the calculation of 30-day risk-standardized mortality and readmission rates.

#### 1.4.2.2. Efficiency

A two-stage stochastic frontier analytical (SFA) analysis is used to determine the measure of hospital efficiency. Production data from the OSHPD are utilized to create a log normalized Cobb-Douglas production function (Douglas, 1976). The Cobb-Douglas production function requires:

- a measure of production output, and
- measure(s) of production input.

The output measure (Y) for this analysis is the total number of discharges from the hospital within the year. This discharge figure includes all hospital discharges including nursery discharges. Production function inputs are:

- productive capacity (C)
- labor (L)
- capital (K)

Productive capacity is derived by summing the total number of available beds and bassinets within a hospital. Labor is derived via the total number of hospital full-time equivalent employees for the year. Capital is derived via net property, plant, and equipment. Control variables in the production function include; type of ownership (government, for profit, not-for-profit), emergency service offered (Y/N), and number of operating rooms within the hospital. Assuming a log-linear Cobb-Douglas form, the stochastic production function takes the form of:

$$\ln Y_i = \ln C_i + \ln L_i + \ln K_i + V_i + U_i$$

where:

$Y_i$  = the expected production output frontier given production function inputs (C,L,K)

$V_i + U_i$  = the extent to which the hospital deviates from this frontier

$V_i$  = random error (noise) components

$U_i$  = systemic technical efficiency (Coelli et al., 2005).

The SFA technical efficiency component produces the measure for efficiency used within this study.

Data Envelopment Analysis (DEA) is an alternative methodology for examining production frontiers and technical efficiencies. DEA was not selected for this study due to its limitation in separating and identifying the random error and systemic technical inefficiency components of the production function error. (Greene, 2008; Kumbhakar & Lovell, 2000)

#### 1.4.2.3. Process Standardization

Process standardization measures provide process of care detail indicating “how often hospitals give recommended treatments known to get the best results for patients with certain medical conditions or surgical procedures. Information about these treatments are taken from the patients’ records and converted into a percentage.” (HCD Updated March 3, 2010, n.p.) Process of care measures for three specific conditions are included within this study; heart attack, heart failure, and pneumonia. These measures are summarized in Table 1.1.

An aggregate process standardization score for each hospital is computed by averaging each of the process scores for each condition into a single hospital average. Missing process scores are not included in the computation of the aggregate process standardization score.

#### 1.4.2.4. Service Effectiveness

Service effectiveness is measured via a Survey of Patients’ Hospital Experiences (HCAHPS) contained within the Hospital Compare Database. Eight items that encompass hospital cleanliness, communication with doctors and nurses, pain control,

Table 1.1: Process Standardization Measure Summary

<b>Heart attack process of care best practice measures</b>	<b>Heart failure process of care best practice measures</b>	<b>Pneumonia process of care best practice measures</b>
Percent of Heart Attack Patients Given Aspirin at Arrival	Percent of Heart Failure Patients Given Discharge Instructions	Percent of Pneumonia Patients Assessed and Given Pneumococcal Vaccination
Percent of Heart Attack Patients Given Aspirin at Discharge	Percent of Heart Failure Patients Given an Evaluation of Left Ventricular Systolic (LVS) Function	Percent of Pneumonia Patients Whose Initial Emergency Room Blood Culture Was Performed Prior To The Administration Of The First Hospital Dose Of Antibiotics
Percent of Heart Attack Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)	Percent of Heart Failure Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)	Percent of Pneumonia Patients Given Smoking Cessation Advice/Counseling
Percent of Heart Attack Patients Given Smoking Cessation Advice/Counseling	Percent of Heart Failure Patients Given Smoking Cessation Advice/Counseling.	Percent of Pneumonia Patients Given Initial Antibiotic(s) within 6 Hours After Arrival
Percent of Heart Attack Patients Given Beta Blocker at Arrival		Percent of Pneumonia Patients Given the Most Appropriate Initial Antibiotic(s)
Percent of Heart Attack Patients Given Beta Blocker at Discharge		Percent of Pneumonia Patients Assessed and Given Influenza Vaccination
		Percent of Pneumonia Patients Given Oxygenation Assessment

responsiveness of hospital staff, quietness, communication about medicines, and discharge information are contained within this survey. Patients report their experiences on a 1-10 Likert scale, with 10 indicating the highest level. HCAHPS reports the number of patients reporting; 6 or lower, 7 or 8, and 9 and 10 for each item. An aggregate service effectiveness score ranging from 0 to 1 is then computed for each hospital.

The HCAHPS survey closely parallels the SERVQUAL multi-item scale used to determine service quality in service (e.g., healthcare) industries (Parasuraman et al., 1988). SERVQUAL evaluates service quality via five constructs. These constructs (with the HCAHPS corollary) are:

Tangibles — physical facilities, equipment, staff appearance, etc. (HCAHPS – cleanliness)

Reliability — ability to perform services dependably and accurately (no direct HCAHPS relationship but addressed within Process Standardization measure by evaluating the degree to which patients receive standardized or reliable care for a range of conditions)

Responsiveness — willingness to help and respond to customer need (HCAHPS – responsiveness of staff)

Assurance — ability of staff to inspire confidence and trust (HCAHPS – communication w/ doctors and nurses)

Empathy — the extent to which caring individualized service is given (HCAHPS – pain control)



#### 1.4.2.5. Operational Focus

Healthcare facilities differ greatly in the breadth of services they offer. This breadth of service can be thought of closely paralleling the “focused factory” concept found throughout OM literature, with narrow service breadth paralleling higher degrees of factory focus. This study computes an Operational Focus (OF) score for each hospital and uses this variable as an indication of hospital focus. This OF score provides a measure of the degree to which an individual hospital focuses on specific procedures or provides a wide variety of procedural services. Individual procedures are coded through a “diagnosis related group” or DRG. Practically speaking, the OF ranges from 0 (a highly specialized facility) to under 10 (a facility offering a broad range of services), due to the limited number of DRGs specified by the Department of Health and Human Services.

Operational focus is ultimately a measure of the hospital’s degree of diversification of services. Varadarajan (1986) devised a methodology determining a measure of diversification. This methodology is modified within this study as the OF score and is operationalized as follows (Sorescu et al., 2003):

$$OF = \sum_{j=1}^n p_j \ln \left( \frac{1}{p_j} \right)$$

where:

**n** = the number of discrete DRGs for which procedures were performed within the given year or reporting period.

**P<sub>j</sub>** = the number of procedures performed at the hospital in the j<sup>th</sup> DRG.

$P$  = the number of procedures performed within the hospital over all DRGs  
 $p_j = P_j/P$ , the fraction of the hospital's procedures performed in the  $j^{\text{th}}$  DRG  
 relative to all procedures performed by the hospital in all DRGs.

### 1.5. Analysis and Results

Ordinary least squared (OLS) regression techniques are used to evaluate hypotheses 1-3, testing the relationships of proposed quality drivers to that of outcome quality. Hypotheses 4-7 are tested utilizing stochastic frontier analysis (SFA) techniques. Finally, supplementary analyses are conducted which utilize quantile regressions. These supplementary analyses are conducted in an effort to evaluate quality versus efficiency relationships and to gain insights as to how these two dependent variables might interrelate.

#### 1.5.1. Drivers of Quality (H1, H2, H3)

To achieve robust results, hypotheses are tested individually and in an additive fashion, beginning with H1, H1 and H2, and finally H1, H2 and H3. Throughout the OLS analysis, control variables for ownership (government, for-profit, and not-for-profit), emergency room status, and accreditation were included. Ownership is included as it is a common explanatory variable in considering healthcare quality (Chesteen et al., 2005). Binary variables for the presence of an emergency room (0 = No ER, 1 = ER present) were included as a proxy for hospital size as no specific size descriptors were available within the HCD dataset. A binary variable for accreditation (0 = not accredited, 1 = accredited) was included to control for possible differences in outcome quality that might be directly attributable to accreditation efforts rather than the hypothesized drivers of outcome quality.

Table 1.2 provides descriptive statistics and pairwise correlations for the variables included in the OLS regression results for hypotheses 1- 3.

The results shown in Table 1.3 demonstrate that Process Standardization (H1) is positively and significantly related to outcome quality alone and in the presence of the other hypothesized drivers. Likewise, Service Effectiveness (H2) is positively and significantly related to outcome quality in the presence of both Process Standardization and Operational Focus. Support for H1 provides evidence that as practitioners adhere to clinical practice guidelines for specific conditions, the quality of care, in terms of reduced combined mortality and readmission rates, is enhanced. Support for H2 indicates that as operational guidelines are adhered to, combined mortality and readmission rates are affected in the hypothesized direction.

The sequential OLS regression results for hypotheses 1-3 are provided in Table 1.3.

Operational Focus (H3) was hypothesized to also contribute to overall outcome quality in keeping with the traditional factory focus arguments that facilities exhibiting narrow product mixes will outperform facilities showing a broader range of products. Contrary to H3, this analysis shows that hospitals exhibiting a broader range of services (measured by DRG services performed) outperformed hospitals exhibiting narrower focus, in terms of overall outcome quality. While not suggestive of a refutation of the factory focus literature, the results in this study suggest other, overriding, explanations of this result within the healthcare environment. The most plausible explanation centers on the well-researched topics of product complexity and the development of core capabilities. Patients (products) entering a system such as a hospital will exhibit a range

Table 1.2: Descriptive Statistics and Correlations for H1 – H3 OLS Regressions DV = Outcome Quality

Independent Variables	Mean	SD	1	2	3	4	5	6	7
1. Process Standardization	.87	.05	1.00						
2. Service Effectiveness	.82	.04	.20**	1.00					
3. Operational Focus	2.41	.44	.24**	.16**	1.00				
<b>Control Variables</b>									
4. Ownership – For-profit			-.03	-.27**	-.07**	1.00			
5. Ownership – Nonprofit			.15**	.21**	.11**	-.68**	1.00		
6. Emergency Service (Y/N)			.02	-.03	.03	-.01	.02	1.00	
7. Accredited (Y/N)			.03	-.00	.04	-.00	.01	.73**	1.00

\*, \*\*  $p < .05$  and  $.01$ , respectively

Table 1.3: H1 – H3 OLS Regression Results, DV = Outcome quality

Independent Variables	H1	H2	H3	H1, H2	H1,H2,H3
Process Standardization	.0479**			.0329**	.0169*
Service Effectiveness		.1174**		.1081**	.0965**
Operational Focus			.0110**		.0094**
<b>Control Variables</b>					
Ownership - For Profit	.0033*	.0071**	.0040**	.0063**	.0062**
Ownership - Nonprofit	.0047**	.0056**	.0048**	.0048**	.0042**
Emergency Service (Y/N)	-.0039	-.0021	-.0038	-.0021	-.0021
Accredited (Y/N)	.0072	.0063	.0061	.0060	.0050
<i>Adj. R-square</i>	.0279	.0617	.0744	.0691	.1123
<i>n</i>	1832	1832	1832	1832	1832

\*, \*\*  $p < .05$  and  $.01$ , respectively

of comorbidities. This is evidenced by the fact that the developers of the Hospital Compare Database (HCD) take specific efforts to provide a risk-standardized measure of mortality and readmission rates, adjusting for patient comorbidities. Those hospitals which are able to treat a wide range of these comorbidities will develop a wider range of core capabilities and exhibit higher overall quality of care, even after adjusting for case mix and hospital capabilities as provided with the source data in this study (see Appendix A). Hence, facilities exhibiting a wider range of patient treatment capabilities will be in a position to provide an enhanced level of service, in this case, outcome quality (Leonard-Barton, 1992). Patients exhibiting an increasing range of comorbidities can be thought of as increasingly complex. Treating these complex customers within a single facility

parallels in-house production of complex products in the management literature (Novak & Eppinger, 2001). This in-house production is preferable, i.e., yields better results, than outsourcing the patient (product) for each set of product characteristics (comorbidities).

#### 1.5.2. Drivers of Efficiency (H4 - H7)

Central to the hypotheses exploring the relationships of the proposed drivers to efficiency is an analysis 1) determining the presence systematic technical efficiencies within the sample, and 2) should technical efficiencies exist, a determination of the relationship between the proposed drivers and technical efficiencies. These two empirical analyses are performed via the two-stage Stochastic Frontier Analysis described previously. Table 1.4 provides descriptive statistics and pairwise correlations for the variables included in the SFA.

Results from the two-stage SFA analysis for hypotheses 4 – 7 are summarized in Table 1.5.

##### 1.5.2.1. Production Function (First Stage) Results

Accounting for all input and control variables yields a significant log-likelihood for the stochastic production function of 11.85 ( $p < 0.01$ ). This result provides support for the notion that the combined input and control variables provide significant value in explaining the output variable (ln\_total beds and bassinets). Additionally, the first stage analysis provides significant evidence of the presence of systematic technical efficiency component ( $\chi^2 = 1052, p < .01$ ). The presence of a significant technical efficiency component allows proceeding to stage 2, estimating the effect of the hypothesized drivers on hospital efficiency.

Table 1.4: Descriptive Statistics and Correlations for Input and Technical Efficiency Variables

<b>Production Function Input Variables</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
1. Productive Capacity	5.54	.61	1.00						
2. Labor	7.07	.75	.88**	1.00					
3. Capital	17.92	1.20	.63**	.74**	1.00				
<b>Technical Efficiency Variables</b>									
4. Process Standardization	.89	.05	.05	.05	.16*	1.00			
5. Service Effectiveness	.81	.04	-.05	.05	.31**	.11**	1.00		
6. Operational Focus	2.41	.44	.64**	.71**	.63**	.24**	-.09**	1.00	
7. Outcome quality	0	.02	-.06	-.09	-.08	.00	-.04	.00	1.00

\*, \*\*  $p < .05$  and  $.01$ , respectively

Table 1.5: H4 – H7 SFA Results, Production Output =ln Discharges

	<b>First Stage Production Function</b>	<b>Second Stage Production Function and Technical Efficiency Function<sup>1</sup></b>
<b>Input Variables</b>		
Productive Capacity (ln (Beds+Bassinets))	.5898*	.4343*
Labor (ln FTE)	.3659*	.3735*
Capital (ln PPE)	-.0140	.0054
<b>Technical Efficiency Variables<sup>1</sup></b>		
Process Standardization		1.118*
Service Effectiveness		-3.160*
Operational Focus		.3132*
Outcome quality		-4.799*
Ownership - Proprietary, for-profit		.7367*
Ownership - Nonprofit		.5482*
<b>Control Variables</b>		
Ownership – Proprietary, for profit	.1263*	.4373*
Ownership - Nonprofit	.0672	.3989*
Emergency Service	-.1029	.0677
Number of Operating Rooms	.0252	-.0106
<b>Variance Parameters</b>		
Sigma – $v^2$	.8732	.0025
Sigma – $u^2$	.0246	.0709
<b>Test for technical efficiency</b>		
Ho: No technical efficiency component	$\chi^2 = 1052^*$	
Log-likelihood function	11.85	27.08
Sample Size ( $n$ )	152	152

Truncated normal distribution, \* $p < .05$ , Similar results with half normal and exponential distributions  
<sup>1</sup>SFA provides technical inefficiency coefficients. Results have been modified to reflect technical efficiency.

### 1.5.2.2. Production Function and Technical Inefficiency

#### Function (Second Stage) Results

In interpreting the stage 2 results, it is important to note that technical inefficiencies are estimated in the baseline analysis, hence changing the signs of the coefficients for the Technical Inefficiency Variables yields estimates of contribution to Technical Efficiency which are used throughout this study.

Hypothesis 4 posits that Process Standardization is positively associated with efficiency. SFA stage 2 results supports this hypothesis (coefficient = 1.118,  $p < .05$ ). In addition to enhancing hospital quality, clinical practice guidelines for specific conditions enhance the technical efficiency of hospitals. Similar to manufacturing environments, process standardization is shown to provide efficiency benefits within the healthcare environment (Kumar & Harms, 2004).

Hypothesis 5 asserts a negative association between service effectiveness and efficiency. The SFA results support this assertion (-3.160,  $p < .05$ ). This effect can be explained by realizing that human resources required to enhance service effectiveness dimensions of cleanliness, communication, pain control, etc. will have a negative impact on overall efficiency within the hospital (Karwan & Markland, 2006).

It should be noted that higher values of the measure “Operational Focus” are associated with lower overall focus within a hospital. Hypothesis 6 proposes that lower focus (higher values of the measure “Operational Focus”) results in lower efficiency. The SFA results do not support this assertion (.3132,  $p < .05$ ). This result can be partially explained by realizing that capabilities developed while treating a patient population with more comorbidities (i.e., higher specialty score, lower operational focus) results in

overall efficiency decreases. The increased resources required to address these wider ranges of comorbidities results in a net drain on efficiency.

Hypothesis 7 posits that Outcome Quality will be negatively associated with Efficiency. SFA results support this assertion (-4.799,  $p < .05$ ).

## 1.6. Discussion

The analysis of the data and accompanying results are insightful for operations researchers and healthcare practitioners. A primary focus and contribution of this study is a determination of the relationship between quality and efficiency within the healthcare setting (Hypothesis 7). Quality and efficiency in the healthcare context can be thought of as competitive capabilities which are pursued by healthcare organizations to gain a competitive advantage. Two schools of thought exist in relation to the development of competitive capabilities. First, capabilities are thought to be acquired in a cumulative or progressive fashion (Ferdows & DeMeyer, 1990; Rosenzweig & Roth, 2004), and second, that trade-off decisions are made in the pursuit of capabilities (Babu & Suresh, 1996; Carey & Burgess, 1999; Pinker & Shumsky, 2000). The results from this study suggest that healthcare facilities would pursue the quality / efficiency capabilities in a trade-off fashion, due to their negative relationship and the cross-sectional nature of this study's data. This trade-off pursuit of capabilities is supported by literature specifically addressing trade-off versus competitive progression (Boyer & Lewis, 2002).

These quality / efficiency findings suggest a short-term versus long term perspective. In the short term, facilities wishing to pursue both quality and efficiency concurrently would encounter difficulties due to their negative relationships. Using a longer-term perspective, facilities might build quality capabilities to a point that enables



them to pursue efficiency gains, suggestive of the competitive progression framework suggested by Ferdows and DeMeyer (1990) and Rosenzweig and Roth (2004).

Evaluation of the individual drivers of quality and efficiency lend further support to this assertion.

Another significant contribution of this research is the confirmation of Hypothesis 1, that adherence to standardized process protocols in the treatment of specific conditions provides measureable and significant enhancements in healthcare quality, as measured by improved outcomes. Current popular and academic literature suggests that there is a tension between healthcare practitioners and administrators of healthcare facilities regarding the implementation of clinical practice guidelines (process standardization) within the practice of healthcare (Boyer & Pronovost, 2010; Gawande, 2009). Providers desire to practice their “craft” with a minimum of outside restriction. Administrators, often responding to regulatory pressures, look to achieve a treatment environment which often approaches an assembly line approach. This research provides empirical support for the notion that practitioners can provide improved outcome results to their patients by following clinically-supported best practices in the treatment of commonly encountered conditions. This does not suggest that practitioners treat each patient identically, but rather simply that they follow a set of clinical practice guidelines combined with their individual experience.

Process standardization also provides significant benefits in the delivery of efficient healthcare (Hypothesis 4). We utilize the relationship of observed productive output to maximum productive output to measure technical efficiency. As hospitals follow clinical practice guidelines, overall technical efficiency is significantly enhanced.

The reasoning behind this result lies in the proposition that more patients are discharged per unit of production input as hospitals follow best practices. This stands to reason in light of the outcome quality / process standardization result. Higher levels of outcome quality result in a greater number of discharges (i.e., fewer mortalities and readmissions) which directly translate to higher levels of technical efficiency. Process standardization pays real dividends in terms of both healthcare quality and technical efficiency.

Per Hypothesis 2, we also find that operational quality (proxied by the measure: service effectiveness) provides significant enhancements to overall healthcare quality. This finding is supported by the service operations literature which suggests a close relationship between customer satisfaction and the overall quality of the service encounter. Over and above the quality benefits of adhering to common treatment protocols, hospitals can also significantly enhance the quality they provide their patients by providing a pleasant, clean, and communicative environment within the facility.

Contrary to the positive operational quality / healthcare quality relationship we find a negative relationship (Hypothesis 4) between operational quality and hospital efficiency. Healthcare facilities invest significant human and capital resources to achieve desired levels of operational quality. The expending of these resources provides little enhancement to the measure of productive output within the hospital. This finding also supports the assertion that short-term trade-offs exist in pursuing healthcare quality and efficiency as discussed in Hypothesis 7. Both process standardization and operational quality contribute positively to healthcare quality. At the same time (per the nature of cross-sectional data), process standardization contributes to and operational effectiveness detracts from overall efficiency. In regimes of high process standardization and

operational quality, hospitals would expect to see higher overall quality enhancements and lower efficiency gains.

The positive contribution of process standardization to both quality (Hypothesis 1) and efficiency (Hypothesis 4) also suggests that process standardization might be the key mechanism by which healthcare facilities pursue the short-term quality / efficiency trade-off discussed above. Pursuing both process standardization and operational quality would provide definite quality enhancements but uncertain efficiency gains, also supportive of short-term trade-offs.

Extant operations literature addressing the effect of operational (factory) focus on quality and efficiency suggest a positive relationship on both. These same relationships were hypothesized (Hypothesis 3, 6) in this study. Rather than finding support for these hypotheses, we found a significant negative relationship between operational focus and both healthcare quality and efficiency. This finding provides a significant and unexpected contribution of this study. As healthcare facilities expand their range of services (i.e., *decrease* operational focus), they concurrently are provided the opportunity to develop an expanding range of competencies. This enhancement of competencies provides the impetus to realize improvements both in terms of healthcare quality and efficiency, as suggested by the empirical results of this study. A recent study by U.S. News and World Report (2011) supports the notion of a broader range of services equating to higher levels of overall quality. Hospitals demonstrating high levels of expertise across a broad range of medical specialties sit atop the magazine's "Best Hospital Honor Roll."

Should healthcare facilities wish to enhance both quality and efficiency, the results of this study suggest that an expansion of the range of services would provide desired improvements. Using the same short-term versus long-term reasoning introduced in the Hypothesis 7 discussion, once facilities have developed process standardization enhancements (short-term, trade-off) they might then focus on developing an enhanced range of services to enhance both quality and efficiency (long-term, competitive progression).

This reasoning is further supported by the extant theoretical frameworks of the Resource Based View of the Firm (RBV) (Barney, 1991; Wernerfelt, 1984) and Absorptive Capacity (Cohen & Levinthal, 1990). RBV posits that as firms develop resources or firm-specific capabilities that are valuable, unique, inimitable, and nonsubstitutable, real competitive advantage accrues to the organization. In the special case of healthcare facilities, the development of these resources occurs as the breadth of services is increased, thereby providing enhanced healthcare quality, a type of competitive advantage. Absorptive Capacity explains the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends. In the context of healthcare, as the range of services is expanded, the hospital (firm) is exposed to varying degrees of previously exogenous knowledge and capabilities. As this knowledge set is assimilated, enhanced commercial capabilities develop in the form of enhanced quality of outcomes and overall efficiencies. These resource development and knowledge assimilation activities are long-term in nature, providing further support for the cumulative progression reasoning in developing both quality and efficiency capabilities within healthcare.

### 1.7. Conclusions and Limitations

The primary contributions of this study are threefold: (1) the positive relationship between healthcare quality and process standardization, (2) the finding that operational focus detracts from both quality and efficiency, and (3) the support found for the quality / efficiency short-term trade-off within the hospital setting. These results provide healthcare practitioners, administrators, and policymakers with empirical support when making decisions regarding quality versus efficiency.

This research suggests which competencies or drivers might be pursued to achieve short- and long-term quality and efficiency gains. In the short-term, process standardization and operational quality might be pursued to achieve quality gains, realizing that the resources required to pursue operational quality enhancements might detract from overall efficiency. Longer-term, hospitals would pursue a wider range of services while maintaining focus on process standardization and operational quality.

This research uses publically-available data for the time frame 2005-2008. Obvious extensions of this study would incorporate additional timeframes to replicate the study to gain longitudinal support for the findings. The greatest contribution of replicating this study with a longitudinal focus would provide empirical support to the long-term competitive progression of quality and efficiency capabilities suggested by this and previous research.

The fact that the efficiency analysis was conducted using data from a single state (California) is a limitation. While California is representative of the U.S. in terms of its demographic profile (Abelson & Harris, 2010), obtaining data from other states and replicating this study is a possible direction for future research.

Technology implementation and its intensity is an oft studied contributor to quality and efficiency dimensions. This study might be enriched by including the technical intensity of individual hospitals as a potential driver of both quality and efficiency.

Operational focus as a contributor to quality and efficiency is studied in terms of a single dimension (DRG services provided). Prior research of factory or operational focus has defined this focus in terms of a multidimensional measure (Heyer et al., 2009; Pesch & Schroeder, 1996). Extensions to this research would include development of a multidimensional scale measure of hospital focus and determining this focus measure's effect on hospital performance measures such as quality, efficiency or financial performance.

## 1.8. Appendix A – Risk-adjusted Mortality and Readmission

Quoted directly from:

U.S. Department of Health and Human Services, Hospital Compare Database website (<http://www.hospitalcompare.hhs.gov/staticpages/for-professionals/ooc/statistical-methods.aspx>)

### Statistical Methods Used to Calculate Rates - Mortality Measures

#### Hierarchical Regression Model

The statistical model for computing 30-day risk-adjusted mortality rate measures is a "hierarchical regression model." This type of model is based on the assumption that any heart attack or heart failure or pneumonia patients treated at a particular hospital will experience a level of quality of care that applies to all patients treated for the same condition in that hospital. In other words, the expected risk of death for two similar heart attack or heart failure or pneumonia patients treated in the same hospital would be more alike than the risk of death for the same two patients treated in two different hospitals. The likelihood that an individual patient will die is therefore a combination of:

- his or her individual risk characteristics (for example, gender, comorbidities, and past medical history) and
- the hospital's unique quality of care for all patients treated for that condition in that hospital.

The model estimates the effects of both of these components on mortality.

#### Calculating Mortality Rates

Each hospital's "30-day risk-adjusted mortality rate" (also called the "Risk Standardized Mortality Rate" or RSMR) is computed in several steps. First, the *predicted* 30-day mortality for a particular hospital obtained from the hierarchical regression model is divided by the *expected* mortality for that hospital, which is also obtained from the regression model. Predicted mortality is the rate of deaths from heart attack or heart failure or pneumonia that would be anticipated in the particular hospital during the 12-month period, given the patient case mix and the hospital's unique quality of care effect on mortality. Expected mortality is the rate of deaths from heart attack or heart failure or pneumonia that would be expected if the same patients with the same characteristics had instead been treated at an "average" hospital, given the "average" hospital's quality of care effect on mortality for patients with that condition. This ratio is then multiplied by the national unadjusted mortality rate for the condition for all hospitals to compute a "risk-adjusted mortality rate" for the hospital. So, the higher a hospital's predicted 30-day mortality rate, relative to expected mortality for the hospital's particular case mix of patients, the higher its adjusted mortality rate will be. Hospitals with better quality will have lower rates.

(Predicted 30-day mortality/Expected mortality) \* U.S. National mortality rate = RSMR

## Statistical Methods Used to Calculate Rates - Readmission Measures

### Hierarchical Regression Model

The statistical model for computing the 30-day risk-standardized readmission rates is a "hierarchical regression model." This type of model is based on the assumption that any heart attack, heart failure, or pneumonia patient treated at a particular hospital will experience a level of quality of care that applies to all patients treated for the same condition in that hospital. In other words, the expected risk of readmission for two similar heart attack, heart failure, or pneumonia patients treated in the same hospital would be more alike than the risk of readmission for the same two patients treated in two different hospitals. The likelihood that an individual patient will be readmitted is therefore a combination of:

- his or her individual risk characteristics (for example, gender, comorbidities, and past medical history) and
- the hospital's unique quality of care for all patients treated for that condition in that hospital.

The model estimates the effects of both of these components on on risk of readmission.

### Calculating Readmission Rates

Each hospital's 30-day risk-standardized readmission rate (RSRR) is computed in several steps. First, the predicted 30-day readmission for a particular hospital obtained from the hierarchical regression model is divided by the expected readmission for that hospital, which is also obtained from the regression model. Predicted readmission is the number of readmissions (following discharge for heart attack, heart failure, or pneumonia) that would be anticipated in the particular hospital during the study period, given the patient case mix and the hospital's unique quality of care effect on readmission. Expected readmission is the number of readmissions (following discharge for heart attack, heart failure, or pneumonia) that would be expected if the same patients with the same characteristics had instead been treated at an "average" hospital, given the "average" hospital's quality of care effect on readmission for patients with that condition. This ratio is then multiplied by the national unadjusted readmission rate for the condition for all hospitals to compute an RSRR for the hospital. So, the higher a hospital's predicted 30-day readmission rate, relative to expected readmission for the hospital's particular case mix of patients, the higher its adjusted readmission rate will be. Hospitals with better quality will have lower rates.

$(\text{Predicted 30-day readmission} / \text{Expected readmission}) * \text{U.S. National readmission rate} = \text{RSRR}$



### 1.9. Appendix B - Supplemental Analysis

The following relationships between the dependent variables hospital *Outcome Quality / Efficiency* and selected predictor variables (drivers) of each have been established. Ordinary least squares regression (OLS) and stochastic frontier analysis (SFA) analytic methods were employed.

#### 1.9.1. Results Summary

- *Outcome Quality – Process Standardization*: Positive relationship. Process standardization has been found to significantly and positively contribute to hospital outcome quality.
- *Outcome Quality – Service Effectiveness*: Positive relationship. Service effectiveness has been found to significantly and positively contribute to hospital outcome quality.
- *Outcome Quality – Breadth of Services*: Note that the measure “Breadth of Services” is interpreted to exactly mirror the measure “Operational Focus” utilized within this study. Facilities exhibiting a high degree of service breadth will, by definition, exhibit a low degree of overall operational focus. Wider Breadth of Services (i.e., reduced Operational Focus) has been found to significantly and positively contribute to hospital outcome quality.

- *Efficiency – Process Standardization*: Positive relationship. Process standardization has been found to significantly and positively contribute to hospital efficiency.
- *Efficiency – Service Effectiveness*: Negative relationship. Service effectiveness has been found to significantly and negatively contribute to hospital efficiency.
- *Efficiency – Breadth of Services*: Note that the measure “Breadth of Services” is interpreted to exactly mirror the measure “Operational Focus” utilized within this study. Wider Breadth of Services (i.e., reduced Operational Focus) has been found to significantly and positively contribute to hospital efficiency.
- *Efficiency – Outcome Quality*: Negative relationship. Outcome quality and efficiency have been found to have a negative, or trade-off, relationship.

In an effort to explore and validate these relationships further while also providing prescriptive managerial insights, this appendix provides the results of several supplemental analytical efforts.

#### 1.9.2. Min – Max Analysis

This analysis examines the predictor variable (driver) effects on outcome quality and efficiency for hospitals residing in the lower 10% (minimum) and upper 10% (maximum) of both quality and efficiency performance. Tables 1.6 and 1.7, and Figures 1.3 and 1.4 provide the results of these analyses.

Table 1.6: Outcome Quality Drivers – Upper and Lower 10%

	Drivers - Average Standard Normal Value		
Outcome Quality	Process Standardization	Service Effectiveness	Operational Focus
Bottom 10%	-0.426	-0.262	-0.424
Top 10%	-0.080	0.289	0.668

Table 1.7: Efficiency Drivers – Upper and Lower 10%

	Drivers - Average Standard Normal Value		
Efficiency	Process Standardization	Service Effectiveness	Operational Focus
Bottom 10%	-0.276	0.360	-0.475
Top 10%	-0.058	0.004	0.304

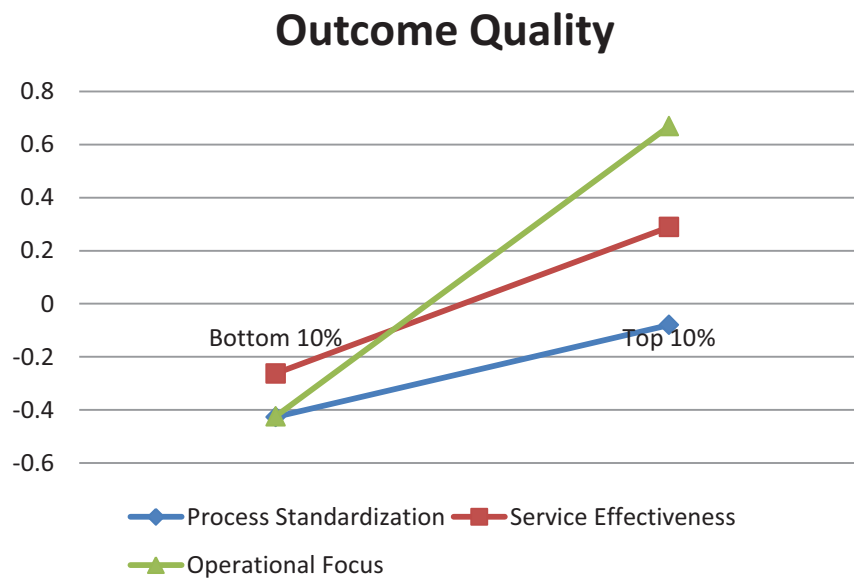


Figure 1.3: Outcome Quality Drivers – Upper and Lower 10%

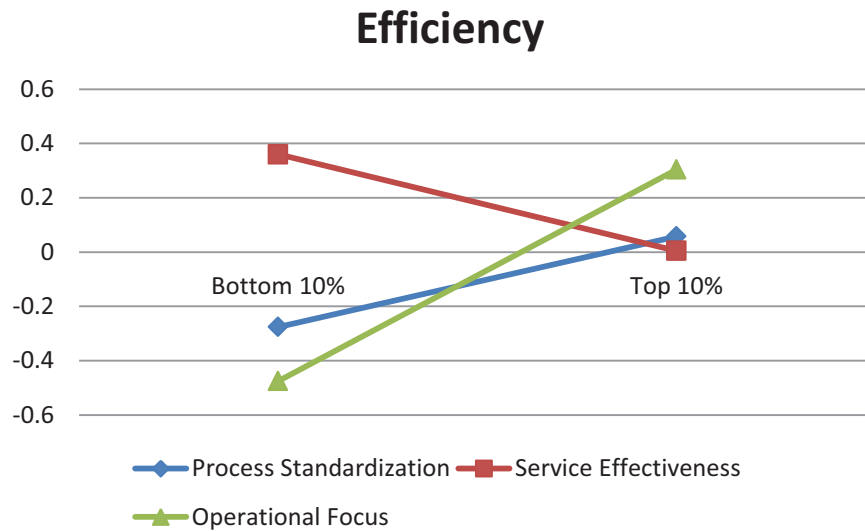


Figure 1.4: Efficiency Drivers – Upper and Lower 10%

From this analysis one can draw the following conclusions as to the drivers' effect on relatively low and high quality / efficiency performers.

#### Drivers of Quality

- To move from a low to a high performing position, all drivers merit enhancement. Managerially speaking, hospitals should consider 1) enhancing conformance to standard treatment protocols, 2) providing attention to enhancing overall operational improvements (i.e., improve the overall patient experience), and 3) enhancing their overall breadth of services. Note that increases in the measure “Operational Focus” are related to increasing overall breadth of services.

#### Drivers of Efficiency

- To move from a low to a high performing position, the drivers *Process Standardization* and *Operational Focus* merit enhancement. Increasing

performance in the driver *Service Effectiveness* detracts from overall efficiency. Managerially speaking, hospitals should consider 1) enhancing conformance to standard treatment protocols, 2) the cost that enhancing overall operational improvements (i.e., improve the overall patient experience) has on hospital efficiency, and 3) enhancing their overall breadth of services.

These findings are consistent with the larger OLS and SFA upon which this study is based, namely, that hospitals which provide clinical services based on established protocols and those which provide a broad range of services provide both higher quality and more efficient care. Providing services that enhance the overall patient experience in terms of patient comfort, room cleanliness, high levels of communication, etc. come at a cost. Overall outcome quality is enhanced, but efficiency is reduced.

### 1.9.3. Multidimensional Analysis

The study next segregates the over 150 hospitals within the study into four quadrants based on their quality and efficiency standing. First, hospitals are mean segregated based on their efficiency score and classified as high or low. Second, hospitals are mean segregated based on their quality score and classified as high or low. Using these efficiency / quality classifications, allows each hospital to be placed into one of four quadrants. Mean scores for each of the standard normalized drivers of quality and efficiency within each quadrant were then computed. Table 1.8 summarizes these results. After placing individual hospitals within the appropriate efficiency / quality quadrant, differences for each driver are computed as one moves from quadrant to adjacent

Table 1.8: Efficiency / Quality Mean Quadrant Scores

Mean Quadrant Scores			
Quadrant (Efficiency, Quality)	Mean Process Standardization	Mean Service Effectiveness	Mean Operational Focus
<b>I (Low,Low) n= 37</b>	-0.115	-0.038	-0.480
<b>II (Low,High) n= 39</b>	-0.044	0.268	-0.023
<b>III (High,Low) n= 39</b>	-0.008	-0.338	0.042
<b>IV (High,High) n= 37</b>	0.152	0.080	0.430
<b>n = 152</b>			

quadrant. This movement from quadrant to quadrant can be thought of in terms of the trade-off / competitive progression frameworks developed within the strategy and operations management literatures. For a more complete discussion of these frameworks, refer to Chapter 3 of this dissertation. The purpose of this analysis is to provide prescriptive managerial insights for placing attention on drivers which would yield beneficial movement within the quality / efficiency matrix. Table 1.9 provides the intra-quadrant difference scores for individual drivers. Those drivers which facilitate maximum beneficial movement across quadrants are termed “order winners.” Those drivers which provide secondary beneficial movement across qualifiers are termed “order qualifiers.” Those drivers which detract from movement across quadrants are classified under “deemphasize.” The order winner / qualifier classifications are used frequently throughout the Operations Management literatures (Childerhouse et al., 2002; Hill, 1985). Order qualifiers are those product / service characteristics which must be present for basic competitive performance (i.e., to qualify to compete). Order winners are those product / service characteristics which must be present for the firm to distinguish it from competitors and “win” within a competitive environment.

Table 1.9: Multidimensional Average Analysis

	<p>Low (1)  High (2)</p> <p><b>Efficiency</b></p>	<p>Low (1)  High (2)</p> <p><b>Quality</b></p>
Low (1)	<p><b>I - Low QE</b></p> <p>Avg. Proc Std: -0.115                  Avg. Srv Eff: -0.038                  Avg. Op Focus: -0.480</p>	<p><b>II - HI Q</b></p> <p>Avg. Proc Std: -0.044     <math>\Delta</math>I-II: 0.071                  Avg. Srv Eff: 0.268     <math>\Delta</math>I-II: 0.306                  Avg. Op Focus: -0.023     <math>\Delta</math>I-II: 0.457</p> <p><b>Prescription: Strong / Order Winner - <u>OP Focus</u></b>                  Weak / Order Qualifier - <u>Srv Eff</u>                  Proc Std</p>
High (2)	<p><b>III - HI E</b></p> <p>Avg. Proc Std: -0.008     <math>\Delta</math>I-III: 0.107                  Avg. Srv Eff: -0.338     <math>\Delta</math>I-III: -0.300                  Avg. Op Focus: 0.042     <math>\Delta</math>I-III: 0.522</p> <p><b>Prescription: Strong / Order Winner - <u>OP Focus</u></b>                  Weak / Order Qualifier - <u>Proc Std</u>                  Deemphasize - Srv Eff</p>	<p><b>IV - HI QE</b></p> <p>Avg. Proc Std: 0.152                  Avg. Srv Eff: 0.080                  Avg. Op Focus: 0.430</p> <p><b>Prescription: Strong / Order Winner - <u>Op Focus</u></b>                  Weak / Order Qual - <u>Proc Std</u>                  Deemphasize - Srv Eff</p>
		<p><b>Path: III - IV</b></p> <p>Avg. Proc Std:     <math>\Delta</math>III - IV: 0.16     <b>Prescription: Strong / Order Winner - <u>Op Focus</u></b>                  Avg. Srv Eff:     <math>\Delta</math>III - IV: 0.418     - <u>Srv Eff</u>                  Avg. Op Focus:     <math>\Delta</math>III - IV: 0.388     Weak / Order Qualifier - <u>Proc Std</u></p>

Consistent with prior analyses, Breadth of Services (Op Focus) is a consistent component of both high quality and high efficiency hospital operations. Hospitals wishing to provide both high quality and high efficiency would be well served to provide a wide range of services to their customers or patients. Service Effectiveness (Srv Eff) comes at a cost when pursuing strictly efficiency. Process Standardization (Proc Std) seems to be a requirement, or order qualifier, when pursuing either quality or efficiency within the hospital environment.

#### 1.9.4. Quantile Analysis

Quantile regression analysis has been performed to evaluate the effect of the drivers (*Process Standardization, Service Effectiveness, Operational Focus*) across quantiles of the dependent variables *Outcome Quality* and *Efficiency*. OLS regression coefficients represent the multiplier effect on the dependent variable (*Outcome Quality* or *Efficiency*) of a unit increase in the independent variable (*Process Standardization, Service Effectiveness, Operational Focus*). While useful in a general sense, it does not provide the dependent / independent variable relationships for varying levels of the dependent variable. Utilizing quantile regression, this study evaluates the relationship between specific percentiles (or quantiles) of the dependent variables and the set of independent variables. The results of this analysis are provided in Table 1.10.

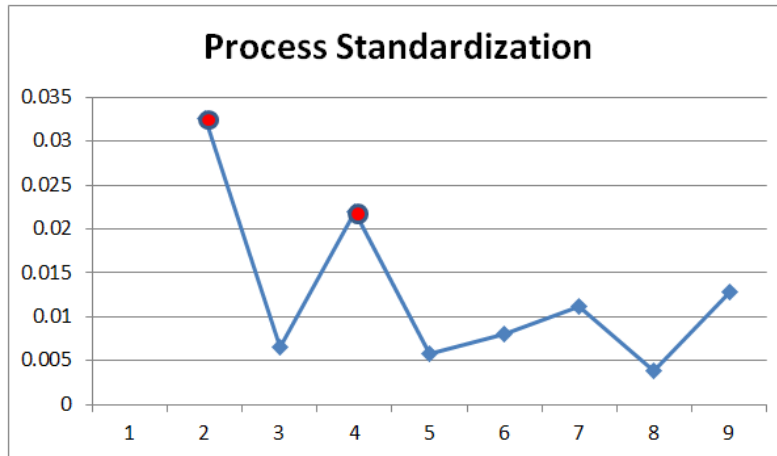
Figure 1.5 provides visual representation of the Outcome Quality Quantile Regressions for ease of prescriptive analysis. A regression coefficient significant at least at the .10 level is signified with ●. The x axis for each figure represents the Quantile Regression Percentile group from Table 1.10, while the y axis represents the independent variable coefficient magnitude from Table 1.10.



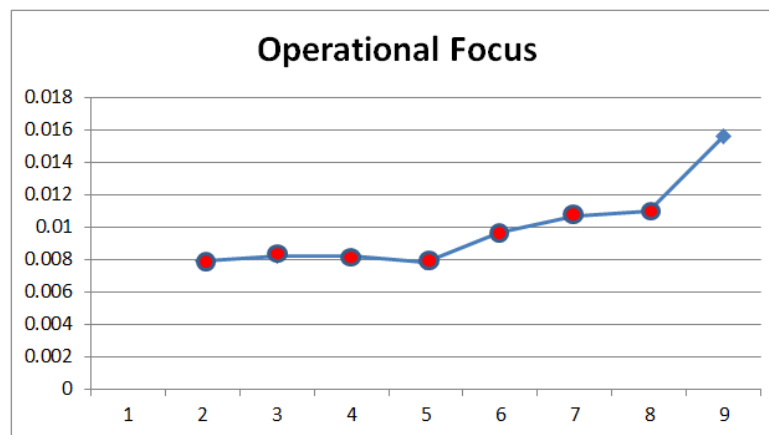
Table 1.10: Parameter estimate – Outcome Quality Quantile Regression

Independent Variable	Quantile Regression Percentile							
	12 <sup>th</sup> (2)	25 <sup>th</sup> (3)	37 <sup>th</sup> (4)	50 <sup>th</sup> (5)	62 <sup>nd</sup> (6)	75 <sup>th</sup> (7)	87 <sup>th</sup> (8)	99 <sup>th</sup> (9)
Process Standardization	<b>0.0325</b>	0.0066	<b>0.0219</b>	0.0058	0.0081	0.0112	0.0038	0.0128
Operational Focus	<b>0.0079</b>	<b>0.0082</b>	<b>0.0082</b>	<b>0.0078</b>	<b>0.0097</b>	<b>0.0107</b>	<b>0.011</b>	0.0156
Service Effectiveness	<b>0.0951</b>	<b>0.1123</b>	<b>0.0957</b>	<b>0.0892</b>	<b>0.0858</b>	<b>0.0724</b>	<b>0.0772</b>	0.1193

**Bold** = Significant at least  $p < .10$



Outcome Quality – Process Standardization Quantile Regression



Outcome Quality – Operational Focus Quantile Regression



Outcome Quality – Service Effectiveness Quantile Regression

Figure 1.5: Outcome Quality Quantile Regression Summary

From these analyses, it becomes apparent that:

- Process standardization (i.e., following clinical protocols) has a greater effect upon providing quality outcomes at the lower percentiles of outcome quality. Hospitals finding themselves working from lower levels of outcome quality would be well served to initially focus on following standardized clinical protocols.
- While not significant within the higher percentiles of outcome quality, process standardization exhibits a decreasing effect upon outcome quality. Hospitals exhibiting higher degrees of outcome quality may rely less on adherence to standardized protocols, due to the underlying quality of their delivery and patient care processes. This underlying quality may be exhibited via the inherent skills and experience in hospital staff in treating patient conditions as they manifest themselves.
- Operational focus (breadth of services) exhibits an increased effect at increasing percentiles of outcome quality. Hospitals should continue to offer that range of services which best serves their patient population.
- Hospitals rely on providing a broad breadth of services to achieve outcome quality, across all quality percentiles.
- While consistently significant, service effectiveness (operational excellence) shows a steadily decreasing fixed effect at increasing levels of quality.

#### 1.9.4.1. Efficiency Quantile Regression

Figure 1.6 provides visual representation of the Efficiency Quantile Regressions for ease of analysis. The x axis for each figure represents the Quantile Regression Percentile group from Table 1.11, while the y axis represents the independent variable coefficient magnitude from Table 1.11.

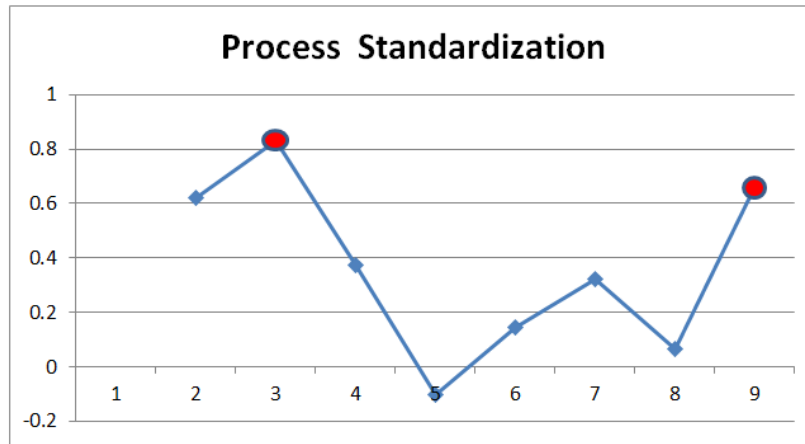
From these analyses, it becomes apparent that:

- Process standardization (following clinical protocols) is more important in efficient healthcare at the lower and higher efficiency percentiles. With process standardization significant only at lower and higher levels of efficiency, the overall effect is negligible. A possible interpretation of this result is that low efficiency hospitals place emphasis on standardized processes in an effort to improve efficiencies, while high efficiency hospitals place emphasis on process standardization in an effort to maintain efficiency.
- Breadth of services (operational focus) is consistently significant across all levels of efficiency. However, the general size of the effect is generally decreasing. This suggests a decreasing returns to scale effect of scope of

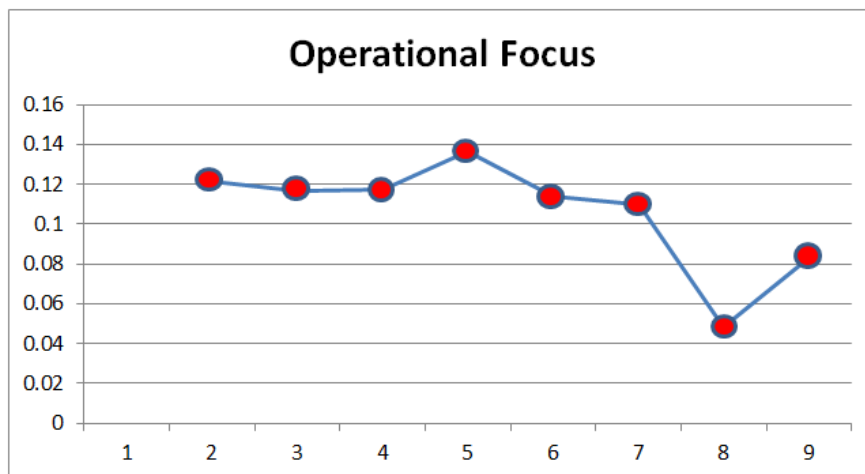
Table 1.11: Parameter estimate – Efficiency Quantile Regression

Independent Variable	Quantile Regression Percentile							
	12 <sup>th</sup> (2)	25 <sup>th</sup> (3)	37 <sup>th</sup> (4)	50 <sup>th</sup> (5)	62 <sup>nd</sup> (6)	75 <sup>th</sup> (7)	87 <sup>th</sup> (8)	99 <sup>th</sup> (9)
Process Standardization	0.619	<b>0.8319</b>	0.3724	-0.1026	0.1438	0.3215	0.0676	<b>0.6636</b>
Operational Focus	<b>0.1212</b>	<b>0.117</b>	<b>0.1176</b>	<b>0.1364</b>	<b>0.1142</b>	<b>0.1096</b>	<b>0.0486</b>	<b>0.0829</b>
Service Effectiveness	-1.078	<b>-1.562</b>	<b>-1.248</b>	-0.6858	<b>-1.373</b>	<b>-1.292</b>	-0.8097	<b>-1.769</b>

**Bold** = Significant at least  $p < .10$



Efficiency – Process Standardization Quantile Regression



Efficiency – Operational Focus Quantile Regression



Efficiency – Service Effectiveness Quantile Regression

Figure 1.6: Efficiency Quantile Regression Summary

services w.r.t overall efficiency. There is a “sweet spot” of the breadth of services which provide the maximum efficiency benefit.

- Service effectiveness (operational excellence) consistently exhibits a negative relationship to efficiency. Across all ranges of efficiency performance, achieving operational excellence must be balanced against its cost to efficiency. This result confirms the earlier SFA and multidimensional results.

#### 1.9.5. Conclusion

This supplemental analysis provides additional insight to the general results defining the relationships between *Outcome Quality / Efficiency* and their proposed drivers, *Process Standardization, Service Effectiveness and Operational Focus*. Using the additional insights gained from these analyses, useful managerial insights can be recognized.

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## CHAPTER 2

### HEALTHCARE FOCUS AND PERFORMANCE: A MULTIDIMENSIONAL EXPLORATION

#### 2.1. Introduction

In an effort to address the U.S. manufacturing sector's "productivity crisis" in the early and mid-1970s, Skinner (1974) introduced the concept of the "focused factory." In Skinner's view, a focused factory would concentrate on a "limited, concise, manageable set of products, technologies, volumes, and markets," governed by a unified manufacturing policy and thereby achieve competitive performance on several dimensions including: process technology, meeting market demands, achieving beneficial product volumes, realizing consistent levels of quality, and deploying appropriate manufacturing tools.

This focused factory concept gained mindshare within the academy (Anderson, 1995; Hayes & Wheelwright, 1984; Schmenner & Swink, 1998), however with limited empirical support. Support for the notion of the focused factory providing competitive advantage was then empirically advanced (Bozarth & Edwards, 1997; Brush & Karnani, 1996; Ketokivi & Jokinen, 2006; Mukherjee et al., 2000; Pesch & Schroeder, 1996). Central to these empirical studies is the notion that manufacturing or factory focus provides its practitioners with measurable performance advantages.

The notion of factory focus has also been applied to the service industry (McLaughlin, 1996; McLaughlin & Fitzsimmons, 1996; Post, 1997; Schmenner, 2004)

with similar predictions regarding enhanced performance on multiple fronts via the employment of a focused range of services.

Treating the healthcare delivery process generally and hospitals or clinics specifically as a type of service industry, prior studies have investigated the relationship of a focused range of services on specific types of performance (Huckman & Zinner, 2008; McLaughlin, Yang & van Dierdonck, 1995). One of the oft studied healthcare facilities exhibiting a positive relationship between a focused range of services and enhanced performance is that of Shouldice Hospital in Toronto, Canada (Bowen & Youngdahl, 1998; Heskett, 1983; Yang et al., 1992). Shouldice Hospital focuses exclusively on performing a limited range of hernia operations with demonstrated results in enhancing overall quality and efficiency, both accepted measures of hospital performance. While these types of specialty care facilities exhibit focus and have been shown to provide quality enhancements (Heskett, 1983), they are not the unit of analysis within this study. This study evaluates the focus – performance relationship within larger, general service hospitals, on which the U.S. Department of Health and Human Services (HHS) gathers data within its Hospital Compare database (Department of Health and Human Services, 2011).

A primary motivator of this study is the results from the first essay of this dissertation suggesting that a focused range of services are a detriment to achieving enhanced performance in terms of quality outcomes and efficiency. This study was limited in that both the measure of service focus and performance were one-dimensional in nature. Hyer et al. (2009) have suggested the need for a multidimensional measure of

hospital focus in extending the concept of manufacturing focus to the service sector within the healthcare setting.

From extant research, covered in detail in Sec. 2.2, there seem to be conflicting results regarding the effect of hospital focus on various measures of performance. The purpose of this study, therefore, is to extend prior research to:

- 1) investigate the effect of hospital focus on hospital performance,
- 2) propose multidimensional measures for both hospital (service) focus and performance within the healthcare setting,
- 3) examine the relationship of each of these measures on focus and performance.

This exploratory study then:

- 1) explores the relationship between hospital focus and hospital performance,
- 2) suggests multidimensional measures for hospital focus within the hospital setting,
- 3) suggests multidimensional measures for hospital performance,
- 4) explores the degree to which each of these multidimensional measures contributes to hospital focus and hospital performance
- 5) compares these relationships to prior theoretical insights from the manufacturing focus literature

The remainder of this study is organized as follows: Section 2 provides a review of the literature, Section 3 conceptually develops the proposed hypotheses, Section 4 summarizes data sources and measures used within the study, Section 5 provides a



summary of the empirical analyses and results, Section 6 presents a discussion of the results and Section 7 provides conclusions and an overview of future directions for this research stream.

## 2.2. Literature Review

As noted above, the concept of factory focus was introduced by Skinner (1974) in an effort to respond to and prescribe solutions to the perceived United States' manufacturing sector productivity decline relative to that of its major foreign competitors (i.e., Japan) during the early- and mid-1970s. He framed the concept of focus in terms of focusing "each plant on a limited, concise, manageable set of products, technologies, volumes, and markets" (Skinner, 1974, p. 114).

This focus would turn the attention of manufacturing managers from an exclusive productivity-improvement dimension to identifying areas where they can successfully compete. This attention in creating competitive competence would encompass the entire manufacturing function as opposed to enhancing the efficiencies of the direct labor force, as had been the norm in productivity-centric manufacturing management. Since Skinner's introduction of the focused factory concept, many studies have been published in the operations, marketing, and management literatures seeking to define, measure, and identify benefits of following this strategy further. The remainder of this review will cover streams of literature relating to:

- A review of the evolution of the definition of factory / manufacturing focus and its extension to service industries, of which healthcare is a part
- A discussion of the different dimensions of focus
- Focus's contribution to performance, particularly that of quality

- An identification of the dimensions of quality, a key measure of performance within the healthcare setting

### 2.2.1. Evolution of Concept of Factory Focus

Recognizing the literature devoted strictly to identifying the benefits of manufacturing focus, Jelinek and Burstein (1982) recognized the need for a compatible management structure to adequately support manufacturing focus. They termed this structure a “Production Administrative Structure” or PAS. Implementing a focused manufacturing environment also requires support of marketing and technology implementation functions. Competitive forces often necessitate the acquisition of new technologies. Implementing these technologies in a strategic fashion that compliments an organization’s choice of focus requires attention to both economies of scale and economies of scope (Noori, 1990). Marketing focus has been seen as a precursor to manufacturing focus (Mathur, 1984). Additionally, understanding an organization’s requirements from a marketing perspective has been seen as being key to developing that organization’s manufacturing strategy or focus (Hausman & Montgomery, 1990). The manufacturing / marketing interrelationship has been further developed in identifying several types of focus, namely, 1) manufacturing characteristics focus, 2) market requirements focus, and 3) a focus on market-manufacturing congruence (Bozarth, 1993).

Factory focus has also been applied to the service industry setting. Yang et al. (1992) applied factory focus to evaluate performance results in U.S. ambulatory surgery centers. The primary advantage of centers exhibiting focus characteristics centered on customer service enhancements such as shorter wait times, higher patient contact and lower overall average facility charges. As stated previously, these facilities are more

specialized in nature and not the more general service facilities studied within this research.

Efforts have been made to establish methods by which focus can be measured, both in the traditional manufacturing and service settings. These methodologies will be referred to in greater detail within the next section, Conceptual Development. Pesch and Schroeder (1996) developed five criteria for measuring what they term “Degree of Focus Score” or DFS:

- 1) A plant’s ability to clearly identify its competitive priorities,
- 2) A demonstrated congruency between competitive priorities and the overarching business strategy of the firm,
- 3) A demonstrated consistency of decision making at the plant,
- 4) Compatible volume levels within a plant (i.e., not mixing high-volume with low-volume orders),
- 5) A compatibility of manufacturing requirements among the various products or product lines produced at a plant.

Hyer et al. (2009) proposed a framework for measuring focus in a healthcare setting utilizing “four perspectives” relying heavily on cellular manufacturing thought.

These perspectives include:

- 1) *Resources* - human and technical, dedicated to processing similar processes,
- 2) *Spatial* – Resources working on similar processes located in close proximity,
- 3) *Transformation* – a system which is designed to perform similar process steps on similar products or product types, and

- 4) *Organizational* – managerial support and decision making resides within the resources working on similar processes.

These efforts to identify multiple dimensions of focus in the manufacturing sector (Pesch & Schroeder, 1996) and in the healthcare service sector (Hyer et al., 2009) and are key to the development of the measures of hospital focus used within this study. A common recurring theme within both of these focus frameworks and this study is a recognition that focused organizations often organize along similar product lines and that processes within the organization are designed to support these product lines (Pesch & Schroeder's "compatible volume levels" and Hyer's "transformation" perspective). This commonality of processes supporting a limited number of product lines will form the basis for the measures of hospital focus examined within this study.

#### 2.2.2. Focus and Performance

As stated earlier, a central research question of this study is to evaluate the relationship between hospital focus and hospital performance and selected measures (i.e., indicator variables) comprising each construct. Significant research has been conducted in exploring the relationships between focus (manufacturing and service) and performance. This section provides a summary of this research.

Expanding on many of Skinner's ideas, Hayes and Wheelwright (1984) provided one of the first investigations of plant focus and overall performance. Among other prescriptions, they supported Skinner's assertion that productivity gains and enhanced competitive capabilities could be achieved by focusing on a relatively narrow set of manufacturing objectives. Schmenner and Swink (1998) suggest that by observing the "Law of Factory Focus" manufacturers can reduce overall process variability and thereby

enhance overall plant productivity. Bozarth and Edwards (1996) provided evidence of enhanced manufacturing performance through what they term “market requirements focus” and “manufacturing characteristics focus,” although they did suggest that some of the disparities arising from competing market requirements and manufacturing focus (e.g., plant-within-a-plant, focused work cells) are not entirely beneficial to performance. Swamidass et al. (1999) conducted a survey-based study using a neural or virtual factory, testing the assumptions of the focused factory concept. Their performance findings were mixed in that focus (i.e., decreased number of product lines) increased return on investment, had a positive effect on management’s perception of manufacturing performance, did not affect cost-of-goods sold, decreased inventory turns, and decreased sales per employee. Mukherjee, Mitchell and Talbot (2000) have provided support for enhanced conformance quality in manufacturing environments with lower part-mix breadth and volume heterogeneity ( i.e., higher levels of factory or manufacturing focus).

Relating specifically to the healthcare environment, Huckman and Zinner (2008) provide evidence of higher output and productivity within clinics that focus on conducting clinical trials as opposed to those including clinical trials with patient care. These authors also noted the improved performance characteristics of Shouldice Hospital (Heskett, 1983) in terms of performing hernia surgeries cheaper, faster, and with improved clinical outcomes. In addition to using a focused ranges of services (i.e., hernia operations) to achieve these performance benefits, the authors of this study also suggested that these performance enhancements might be explained by other factors including returns to scale, learning effects, and a favorable risk selection in treating only

patients who can travel relatively long distances to receive hernia surgery, suggesting better overall health than the general population.

Research was recently conducted within Dutch hospitals' obstetric departments. These hospitals were organized according to focused factory concepts but not operating to these same concepts in providing care (Pieters et al., 2010). The study suggests that while the department might ideally seek to organize along focused factory theory, they are forced out of this mode as the need to provide the level of care required by obstetric patients. This suggests that hospitals might abandon focused factory organization in the pursuit of achieving desired quality performance.

A recent study of U.S. hospitals providing cardiovascular care suggests a positive relationship between focus and quality performance, measured by mortality rates (Clark & Huckman, 2011). It should be noted that the measures of quality and focus differ in the Clark and Huckman study and this study. Their measure of focus was the percentage of patients at a hospital in a given year who were provided a specific primary diagnosis, in their case, cardiovascular diagnoses. The measure of focus in this study is not related to a specific diagnosis, but rather the degree to which a hospital offers services across a wide range of services. Their measure of quality is similar to this study's, namely a risk-adjusted measure of mortality. Their study seems to include hospital-level mortality rates, whereas this study limits mortality to specific condition groups.

From the mixed results of the previously-mentioned studies, it can be concluded that the relationship between overall performance measures and factory and service / healthcare focus has not been definitively established and is an area open to further

inquiry. Figure 2.1 shows the direction of the proposed hospital focus / performance relationship which will be analyzed within this study.

### 2.2.3. Quality Contribution to Performance

A goal of this study is to suggest and evaluate measures of performance within the healthcare environment. As noted above, some prior literature has suggested a connection between focus and various performance measures, including quality. The literature recognizes that quality is a multidimensional construct. This review does not attempt to capture the full extent of these quality frameworks, but rather to establish that quality is viewed as a multidimensional performance construct within the product, service, and healthcare environments. Garvin (1987) suggests eight quality dimensions for goods and services: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. The service operations literature often utilizes the SERVQUAL framework as a multidimensional measure of service quality (Zeithaml et al., 1990). The dimensions of service quality addressed by SERVQUAL include reliability, assurance, tangibles, empathy, and responsiveness.

Within the healthcare environment, the Institute of Medicine Crossing the Quality Chasm: A New Health System for the 21st Century (2001) has established six dimensions of quality healthcare: safety, timeliness, effectiveness, efficiency, equity and patient-centeredness. This study will evaluate various aspects of hospital quality using

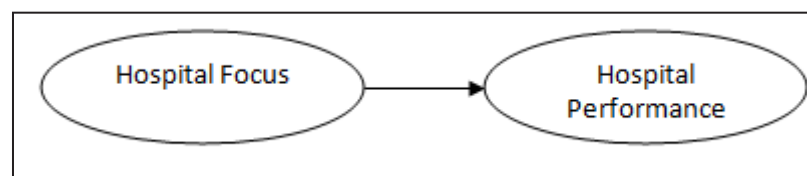


Figure 2.1: Hospital Focus / Performance Relationship

selected IOM dimensions of healthcare quality as key components of overall hospital performance.

### 2.3. Conceptual Development

Using theoretical insights and prior literature, this section will develop:

- multidimensional measures for focus within the hospital setting
- multidimensional measures for hospital performance
- relationships between these multidimensional measures of hospital focus and performance.

#### 2.3.1. Measures of Service Focus

The first essay of this dissertation suggested a single item measure of hospital focus and its relationship to quality and efficiency, both hypothesized measures of hospital performance (Crossing the Quality Chasm: A New Health System for the 21st Century, 2001). Prior literature (Hyer et al., 2009) has suggested the need to develop a multidimensional measure of hospital focus in examining the relationships between focus and performance. This study therefore expands on both of these prior studies and suggests a multidimensional measure of hospital focus.

Pesch and Schroeder (1996) and Hyer et al. (2009) both suggest a framework for evaluating the dimensions of focus. Two of the determinants of focus within these studies, compatible volume levels among products (Pesch & Schroeder, 1996) and the transformational perspective suggested by Hyer et al. (2009) form the basis for the measures of hospital focus within this study. These determinants of focus relate closely with much of prior focus literature, relating focus to product breadth, number of specific



product lines, and variation among existing product lines. Using these determinants of focus, the following four measures of hospital focus are included within this study:

- Hospital Specialty Score (HSS)
- Number of General Lines of Service Within the Hospital
- Volume Levels Among Products
- Number of Specific Service Lines Exhibiting Procedure Activity

The following subsections elaborate on the four measures.

#### 2.3.1.1. Hospital Specialty Score (HSS)

Hospital specialty score (HSS) is defined within this study as the normalized range or scope of services offered within the hospital. The range of services offered within individual hospitals are reported to HHS as the total number of procedures performed within each DRG, or Diagnostic Related Group. Individual hospitals often exhibit clinical competencies based either on the population served or on the specific strategic direction dictated by hospital management. Therefore, individual hospitals will often exhibit varying levels of procedural breadth.

The HSS can be thought of in terms of a continuum. One extreme is occupied by specialty hospitals which, by design, focus on a narrow range of services. The other extreme would represent hospitals which offer as wide a range of services as possible, taking local needs, resources and strategic direction into account. As noted earlier, an example of a specialty hospital is Shouldice Hospital. This hospital is designed to provide a limited range of services focused on external abdominal wall hernia surgery. Other specialty hospitals might focus on respiratory care, orthopedic services, long-term acute care, or outpatient surgeries. These types of hospital are not the focus of this study.

The evaluation of HSS as a measure of hospital focus envisioned in this study pertains to general service hospitals providing a relatively wide range of services and can therefore be extended to a much larger and more ubiquitous sample of healthcare facilities.

#### 2.3.1.2. Number of General Lines of Service Within the Hospital

Skinner states: “A factory that focuses on a narrow product mix for a particular market niche will outperform the conventional plant, which attempts a broader mission” (1974a, p. 114).

While not specifically stating that a narrow product mix or limited number of product lines leads to improved performance, Skinner did seem to include the number of product lines as at least an indication of the measure of focus within a particular facility. Within the healthcare literature, it has also been suggested that facilities which focus on a limited number of product lines are able to develop “centers of excellence” and attract patients from a wide geographic area (MacStravic, 1986).

While the proposed HSS measure provides a normalized continuum measuring the relative degree of specialization within a hospital, the Number of General Lines of Service measure simply provides an indication of the number of lines of service offerings within a given hospital. Hospitals within the data set for this study report the number of procedures performed within specific DRGs. These DRGs are grouped according to general service lines, giving rise to the measure “Number of General Lines of Service Within the Hospital.”

The number of general product (service) lines has a tradition of being included as a key indicator of focus within the literature. In addressing product volume as a determinant of focus Skinner (1974) noted, “Generally, these (product volumes) are of

comparable levels, such that tooling, order quantities, materials handling techniques, and job contents can be approached with a consistent philosophy” (p. 116). From this beginning, it appears that the benefit of consistent product volumes accrues to the organization in the form of providing consistent managerial attention and decision-making. Application of product (service) line management as a contributor to focus and performance within the healthcare industry has also been shown to be beneficial (Hoffman, 1986; MacStravic, 1986, Manning, 1987; Ruffner, 1986).

#### 2.3.1.3. Volume Levels Among Products

In addition to providing a normalized and absolute indication of the number of service lines provided within a hospital, this study also includes a measure of consistency among procedures within service lines. This is closely related to Pesch and Schroeder’s (1996) “Compatible Volume Levels Among Products” dimension within their Degree of Focus Score (DFS) measure. While hospitals may perform procedures across all common service lines, they may conduct a disproportionately large number of procedures within a small number of service lines. This measure is intended to capture the degree to which hospitals focus their efforts on a relatively small number of service lines, although they might conduct procedures across a relatively large number of service lines.

This Volume Level among Products can be thought of as capturing the level of heterogeneity of manufacturing part volumes in a manufacturing setting. This heterogeneity introduces mismatched batch volumes, decreasing overall line performance (Mukherjee et al., 2000).

#### 2.3.1.4. Number of Specific Service Lines Exhibiting Procedure Activity

Within each general service line (e.g., pulmonary, orthopedic, etc.) within this study, there exists a number (two to six) of more specific lines of service. This measure is an indication of the number of those specific lines of service a particular hospital services. While closely related to the Number of General Lines measure, this more specific measure provides an additional degree of specificity in determining overall hospital focus.

#### 2.3.1.5. Hospital Focus Conceptual Model

Using the above directly-observed items (i.e., indicators) as measures of the latent construct, Hospital Focus, the conceptual model of Figure 2.2 is proposed. Note that the indicator – latent construct relationship is modeled utilizing standard confirmatory factor analysis and structural equation modeling conventions wherein the path (i.e., arrow) flows from the latent construct to indicator.

This study will examine the relationship of each of these proposed measures of hospital focus to the latent construct “Hospital Focus.” It should be noted that as HSS, Number of General Lines of Service and Number of Specific Lines of Service measures of hospital focus increase in value, the breadth of service increases, reducing focus. This reflects the continual nature of the construct, ranging on the low end to highly focused hospital or specialty clinic to the high end, more generalized hospitals, offering a wider breadth of services. The measure Volume Levels provides an indication of the degree of heterogeneity among procedures, or lines of service within a hospital.

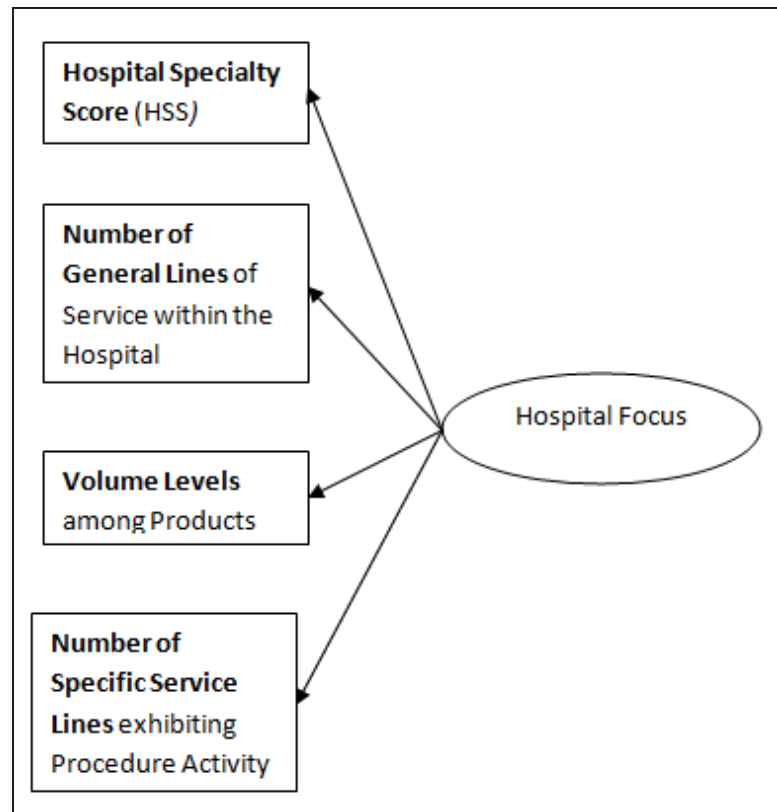


Figure 2.2: Hospital Focus – Conceptual Model

### 2.3.2. Measures of Hospital Performance

Measures of hospital or healthcare performance are frequently evaluated in terms of quality measures and financial measures (Griffith et al., 2002; Li & Collier, 2000; Raju & Lonial, 2002). In evaluating multidimensional measures of hospital performance and then evaluating the impact of hospital focus on hospital performance (both latent constructs), this study likewise includes separate measures of quality and an overarching indicator of financial performance as multidimensional measures of Hospital Performance.

### 2.3.2.1. Quality Performance Measures

One of the three bodies that make up the U.S. National Academy of Sciences, the Institute of Medicine (IOM), has identified separate dimensions of healthcare quality (Crossing the Quality Chasm: A New Health System for the 21st Century, 2001). These quality dimensions are often used for evaluating current quality and directing quality enhancement efforts within the U.S. healthcare system. These dimensions of quality include:

- “*Safety*: — avoiding injuries to patients from the care that is intended to help them.”
- “*Effectiveness*— providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and overuse, respectively).”
- “*Patient-centeredness*— providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions.”
- “*Efficiency*— avoiding waste, including waste of equipment, supplies, ideas, and energy.” (Crossing the Quality Chasm: A New Health System for the 21st Century, 2001)

It is from these dimensions of healthcare quality that proposed measures of hospital quality performance will be derived.

### 2.3.2.2. Financial Performance Measure

A common measure of financial performance within the healthcare industry is that of “Operating Margin” (Ozcan & McCue, 1996; Parente & Dunbar, 2001; Smith et

al., 2000). Indeed, five leading textbooks on healthcare financial management agree that operating margin be used as the measure of overall hospital financial performance (Flex Monitoring, 2008). Operating Margin is defined within this study as the ratio between Net Revenue from Operations and Total Operating Expense. Both these measures are reported within the California OSHPD database.

Using the indicators of hospital quality and financial performance, the multidimensional conceptual model of Hospital Performance depicted in Figure 2.3 will be evaluated. Again, note that the indicator – latent construct relationship is modeled utilizing standard confirmatory factor analysis and structural equation modeling conventions wherein the path (i.e., arrow) flows from the latent construct to indicator.

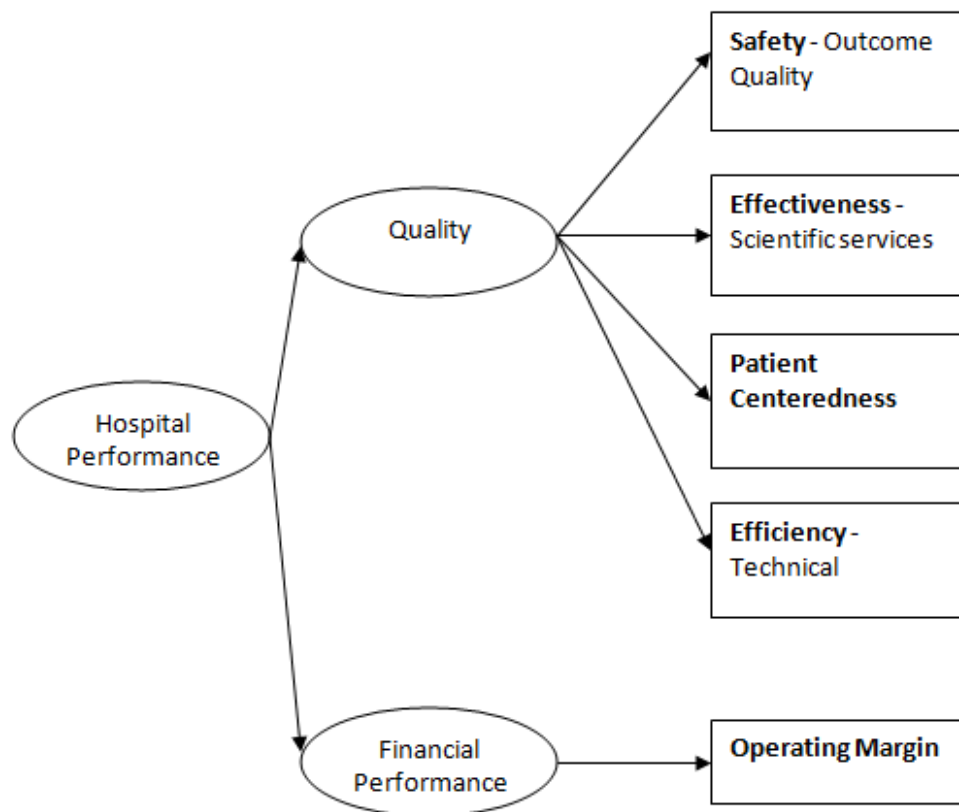


Figure 2.3: Hospital Performance – Conceptual Model

### 2.3.2.3. Hospital Focus and Performance Conceptual Model

As outlined in Section 1 this study:

- 1) suggests multidimensional measures for service focus within the hospital setting
- 2) suggests multidimensional measures for hospital performance
- 3) explores the degree to which each of these multidimensional measures respectively contribute to hospital focus and hospital performance
- 4) explores the broader relationship between hospital focus and hospital performance, using multidimensional measures of both
- 5) compares these relationships to prior theoretical insights from the manufacturing focus literature

Using the multidimensional conceptual models of Hospital Focus and Hospital Performance defined in Figures 2.2 and 2.3, the conceptual model depicted in Figure 2.4 is hypothesized.

### 2.3.2.4. Hospital Focus and Performance Relationships

In that one of the key contributions of this study is to examine the relationship of hospital focus on hospital performance (item 4 above), this section develops proposed relationship(s) between the latent construct Hospital Focus and the observed Hospital Performance factor indicators.

#### 2.3.2.4.1 Hospital Focus – Safety Relationship

Within a surgical hospital setting, it has been suggested that higher levels of safety can be achieved in facilities focusing strictly on out-patient services (i.e., focused) as opposed to those facilities offering both in-patient and out-patient procedures. (Yang et



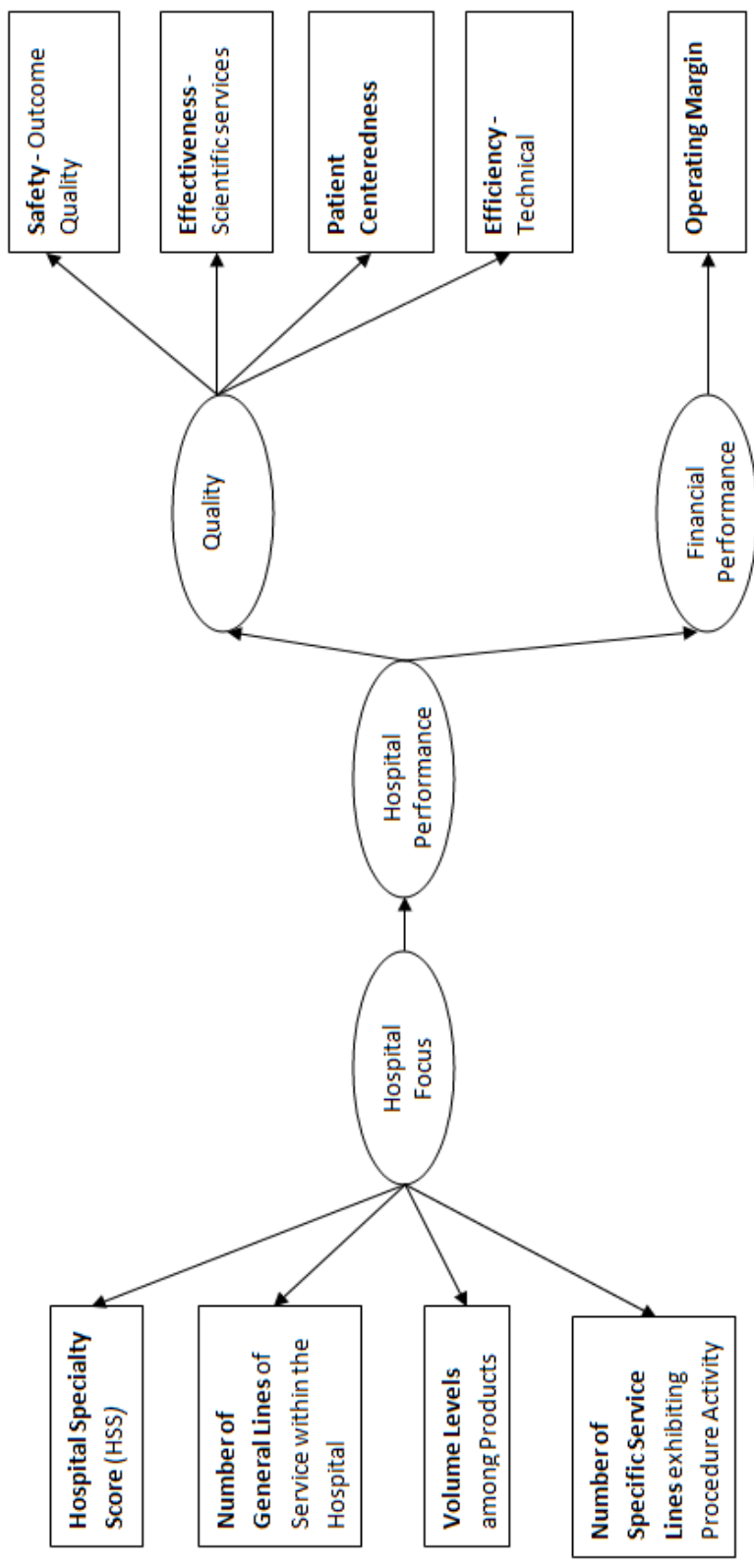


Figure 2.4: Hospital Focus and Performance – Full Conceptual Model

al., 1992). Organizations focused *only* on conducting clinical trial research have been found to exhibit higher levels of operational performance than those conducting clinical trials *and* traditional patient care (Huckman & Zinner, 2008). Operational performance is linked to safety in that a key aspect of any clinical trial is establishing that a particular drug is safe for its intended clinical use. Clinical trials on “unsafe” drugs will result in fewer patient enrollments in subsequent phases of drug testing. These patient enrollments are used as an ultimate measure of operational performance.

The above healthcare literature suggests that hospitals exhibiting a higher degree of focus can be expected to also exhibit higher levels of safety, a key measure of hospital performance.

The first paper of this dissertation suggests that hospitals offering a broader range of services (i.e., lower focus) exhibit higher degrees of outcome quality. This relationship seems to be at odds with extant hospital / healthcare research and will be explored further within this research.

#### 2.3.2.4.2 Hospital Focus – Effectiveness Relationship

Effectiveness, as defined by the IOM as a contributor to hospital quality is “providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit” (Crossing the Quality Chasm: A New Health System for the 21st Century, 2001). Applying and extending this definition to more traditional factory focus settings would lead one to surmise that facilities exhibiting a high degree of focus would also exhibit procedures, policies, etc. that are more based on current scientific practices. Additionally, facilities exhibiting focus will refrain from “over-engineering” their processes and procedures.

The sociology literature, however, suggests that companies offering a wide variety of products to their customers are more effective in uncertain environments (Freeman & Hannan, 1983). General service hospitals operate in an uncertain environment in relation to the demand on its services, both in quantity and type of service.

#### 2.3.2.4.3 Hospital Focus – Patient Centeredness Relationship

Patient-centric hospitals provide “care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions” (Crossing the Quality Chasm: A New Health System for the 21st Century, 2001). Herzlinger (1997) describes a focused healthcare organization as one that is multidisciplinary, yet focused on common objectives. This commonality among objectives in the healthcare setting has been described as being patient-centered (Bredenhoff et al., 2010).

#### 2.3.2.4.4 Hospital Focus – Efficiency Relationship

The benefit of enhanced efficiency was one of the motivating factors of Skinner’s (1974) original factory focus paper. He proposed that achieving the productivity gains necessary to realize requisite manufacturing competitiveness could be realized largely by developing focus. In the healthcare environment, efficiency has also been shown to derive from enhanced focus (Yang et al., 1992). Using a one-dimensional measure of hospital focus, the first essay of this dissertation found a negative relationship between what was termed “Operational Focus” and efficiency. As this study incorporates a multidimensional measure of hospital focus, this finding should be reevaluated.

#### 2.3.2.4.5 Hospital Focus – Financial Performance Relationship

Hayes and Wheelwright (1984) suggest a negative relationship between operating margin (a measure of financial performance) and the number of product lines manufactured within a given facility. Other authors have also suggested and found evidence of a negative relationship between lack of focus and operating performance, all within the manufacturing environment (Anderson, 2001; Bozarth & Edwards, 1997; Vokurka & Davis, 2000).

### 2.4. Data Sources and Measures

#### 2.4.1. Data Sources

Data for the study are derived from two secondary sources;

- The U.S. Department of Health and Human Services Hospital Compare Database 2005 – 2008 (HCD)
- The State of California Office of Statewide Planning and Development Annual Financial Data 2008 (OSHPD)

##### 2.4.1.1. Hospital Compare Database (HCD)

The HCD provides hospital-provided and patient survey data on how well U.S. hospitals care for patients with a variety of medical conditions. This publically-available data set is updated quarterly and comprises data on a rolling annual basis. Hospitals voluntarily agree to submit patient-level data to the Department to Health and Human Services. The administrators of the data then aggregate the data from the patient level to hospital level, which is ultimately made available on the quarterly basis noted above. The database's purpose is two-fold. First, healthcare consumers can evaluate the

availability and relative quality of care at hospitals they are considering for the provision of care via a series of predesigned queries. Second, the contents of the database are available for download and are intended for use by healthcare researchers and policymakers. This downloaded database forms the basis of the data used within this study.

The downloaded HCD data, while consisting of over a dozen separate database files, primarily focuses on the following general measures: Process of Care, Outcome of Care Outpatient Imaging Efficiency, and a Patients' Survey of Hospital Experiences. This study utilizes data from the Process, Outcome, and Patients' Survey data.

#### 2.4.1.1.1 Process of Care Measures

The administrators of the HCD gather process of care measures on five (5) separate conditions: Heart Attack (Acute Myocardial Infarction or AMI), Heart Failure, Pneumonia, Surgical Care Improvement Project, and Children's Asthma Care. Process of Care data for only the first three conditions are utilized within this study. The reason for excluding the final two conditions is there being no equivalent reporting of Outcome of Care measures for these conditions. Each condition has four (4) to eight (8) separate recommended standard procedures which are recommended to be performed on patients exhibiting the given condition. The National Quality Forum (NQF) defines which procedures will be identified as standard procedures in treating individual conditions. The NQF is a separate, multistakeholder and independent organization which was created to "develop and implement a strategy for health care quality measurement and public reporting" (Department of Health and Human Services, Technical Appendix, n.d.).

Process of Care measures are reported as the percentage of applicable cases exhibiting the given condition which received the given recommended procedure.

#### 2.4.1.1.2 Outcome of Care Measures

Outcome of Care measures consist of two separate individual outcome measures for each of the conditions Heart Attack (Acute Myocardial Infarction or AMI), Heart Failure and Pneumonia. These two outcome measures are 30-day risk-adjusted mortality and, 30-day risk adjusted readmission. Each of these measures is rigorously risk-adjusted to account for hospital-level and patient-level dissimilarities. Appendix A provides a complete discussion of the statistical procedures utilized to achieve this risk-adjustment.

#### 2.4.1.1.3 Patients' Survey of Hospital Experiences

The survey of patients' hospital experiences (Hospital Consumer Assessment of Healthcare Providers and Systems - HCAHPS) is a standardized survey instrument administered by either individual hospital or approved third-party vendors to determine patients' satisfaction with specific in-hospital experiences. This survey can be administered via a number of modalities, consisting of, 1) Mail only; 2) Telephone only; 3) Mixed (mail followed by telephone); and 4) Active Interactive Voice Response (IVR). A random sample of patients is contacted to respond to this survey between 48 hours and 6 weeks after discharge. The survey contains 27 total but 18 "core" questions regarding patients' hospital experiences. (Department of Health and Human Services, Survey of Patients' Hospital Experiences (HCAHPS), n.d.).

The HCD is used to derive the following sets of Performance Measures: Safety (Outcome quality), Effectiveness, Patient Centeredness, and Efficiency. The HCD is

used to derive each of the Focus Measures (Hospital Specialty Score, Number of General Lines of Service Within the Hospital, Volume Levels Among Products, Number of Specific Service Lines Exhibiting Procedure Activity).

The individual HCD quarterly-updated data sets are reported within this study include the years 2005-2006, 2006-2007, and 2007-2008 for the July – June timeframe. Mortality and readmission rates used in creating the Safety performance measure are reported for the 3-year 2005-2008 timeframe. To maintain consistency of data, other performance measures were combined to mirror the same timeframe as reported within the mortality / readmission data. Complete measures exist for 1,832 U.S. hospitals and 152 California hospitals.

#### 2.4.1.2. California Office of Statewide Planning and Development Annual Financial Data 2008 (OSHPD) Database

The OSHPD is designed to provide public access to data on California healthcare facilities' infrastructure, outcomes, finances, safety, and capacity. These data are provided to allow residents, researchers, and policymakers access to data on which they can rely.

The OSHPD contains detailed production and financial data used in developing the efficiency measures used in this study. Measures used within this study include the number of discharges, the number of hospital full time equivalents, net property, plant and equivalents, and the number of beds and bassinets. Supplemental financial performance analysis utilizes net operating income. Data for a total of 152 California hospitals are utilized within this study.

## 2.4.2. Measures

Measures used within this study are divided into two separate subgroups; 1) Measures of hospital focus and, 2) Measures of hospital performance.

### 2.4.2.1. Measures of Hospital Focus

Measures of hospital focus include 1) Hospital Specialty Score (HSS), 2) Number of General Lines of Service Within the Hospital, 3) Volume Levels Among Products and 4) Number of Specific Service Lines Exhibiting Procedure Activity.

#### 2.4.2.1.1 Hospital Specialty Score

Healthcare facilities differ greatly in the breadth of services they offer. This breadth of service is a critical component of a hospital's overall measure of focus. This study computes a Hospital Specialty Score (HSS) score for each hospital and uses this variable as one of four items in determining a hospital's overall measure of focus. This HSS score provides a measure of the degree to which an individual hospital focuses on specific procedures or provides a wide variety of procedural services. Individual procedures are coded through a "diagnosis related group" or DRG. Practically speaking, the HSS ranges from 0 (a highly specialized facility) to under 10, due to the limited number (46 total) of DRGs specified by the Department of Health and Human Services.

Hospital Specialty Score is ultimately a measure of the hospital's degree of diversification of services. Varadarajan (1986) devised a methodology determining a measure of diversification. This methodology is modified within this study as the HSS and is operationalized as follows (Sorescu et al., 2003):



$$\text{HSS} = \sum_{j=1}^n p_j \ln \left( \frac{1}{p_j} \right)$$

where:

$n$  = the number of discrete DRGs for which procedures were performed within the given year or reporting period.

$P_j$  = the number of procedures performed at the hospital in the  $j^{\text{th}}$  DRG.

$P$  = the number of procedures performed within the hospital over all DRGs

$p_j = P_j/P$ , the fraction of the hospital's procedures performed in the  $j^{\text{th}}$  DRG relative to all procedures performed by the hospital in all DRGs.

#### 2.4.2.1.2 Number of General Lines of Service Within the Hospital

The number of general lines of service within each hospital is computed by grouping the 46 individual DRG's into one of six "product lines." These product line groupings include (number of DRGs) pulmonary (2), circulatory (13), gastro-intestinal (10), orthopedic (12), renal (5), and reproductive (4) procedure groups. For each hospital within the sample, the number of product lines where at least one DRG is performed is summed to determine the total number of product lines within the facility. The product line measure ranges from a low of 1 to a high of 6.

#### 2.4.2.1.3 Volume Levels Among Products

This measure of focus is the variance in the number of procedures performed within each general line of service. Facilities with a high variance indicate that a particular hospital performs some procedures very rarely relative to other procedures. Procedures that are performed more frequently can be thought of as being "core" to that hospital's business. Equating this measure to prior literature, this measure captures

incompatibility among product volumes. Facilities with a low variance are indicative of a compatible volume level among products (Pesch & Schroeder, 1996).

#### 2.4.2.1.4 Number of Specific Service Lines Exhibiting Procedure Activity

This measure is determined by computing the total number of DRGs with at least one procedure reported as being performed for each hospital within the sample. This measure ranges from a low of 1 to a high of 46.

#### 2.4.2.2. Measures of Hospital Performance

The following measures of hospital performance are included within this study: hospital safety, hospital effectiveness, hospital patient centeredness, hospital efficiency, and hospital financial performance.

##### 2.4.2.2.1 Hospital Safety

Hospital safety is equated to overall mortality and readmission rates for each facility within the study. Patients are safer in hospitals that exhibit relatively lower mortality and readmission rates. Thirty-day risk-standardized mortality and readmission rates for each condition at each hospital are summed to create a safety score for each of the three conditions (heart attack, heart failure, and pneumonia) included in the study. While data are available for other conditions, these three conditions were specifically selected due to the correspondence of these measures with other data reported within the HHS data set (e.g., process of care best practices performed for a given condition). This provides a robust data set which provides the data breadth and depth required for a study of this type. These combined scores are then averaged to create an overall outcome quality score for individual hospitals. This overall outcome quality score is then used as

the measure of hospital safety within the subsequent analysis. It should be noted that low to high mortality and readmission rates are equated with high to low safety measures.

Risk-standardized mortality and readmission rates are often used as indicators when studying outcome quality (Davies & Crombie, 1995; Krumholz et al., 2006; Krumholz & Normand, 2008; Morey et al., 1992). This risk-standardized methodology overcomes a common critique of using outcome measures as a proxy for quality or safety, namely that their interpretation is dependent upon the case mix and other hospital specific variables. Risk-standardized outcome measures specifically overcome this limitation and provide a robust proxy for hospital safety.

The risk-standardization utilizes a hierarchical regression model is utilized to compute hospital-specific 30-day readmission rates. (Note: This hierarchical regression is not part of this study. Data within the dataset have already been subjected to this regression.) Specific patient-level factors considered in determining the risk-standardized mortality and readmission rates include gender, existing comorbidities, and past medical history. Specific hospital level factors utilized in determining the risk-standardized mortality and readmission rates include the unique quality of care for all patients treated for that condition in that hospital. Appendix A contains more a more detailed description of the calculation of 30-day risk-standardized mortality and readmission rates.

#### 2.4.2.2.2 Hospital Effectiveness

Hospital effectiveness measures provide process of care detail indicating “how often hospitals give recommended treatments known to get the best results for patients with certain medical conditions or surgical procedures.” Information about these treatments are taken from the patients’ records and converted into a percentage.” (HCD

Updated March 3, 2010, n.p.) Process of care measures for three specific conditions are included within this study; heart attack, heart failure, and pneumonia. These measures are summarized in Table 2.1.

An aggregate effectiveness score for each hospital is computed by averaging each of the process scores for each condition into a single hospital average. Missing process scores are not included in the computation of the aggregate process standardization score.

#### 2.4.2.2.3 Hospital Patient Centeredness

Four separate items from the Survey of Patients' Hospital Experiences (HCAHPS) are aggregated to determine the latent variable "patient centeredness." These survey items include: How often did doctors communicate well with patients?, How often did nurses communicate well with patients?, How often was patients' pain well controlled?, How often did staff explain about medicines before giving them to patients? Each of these items are reported within the HCAHPS survey as the percentage of patients providing the responses: always, sometimes, and never. These responses are then weighted to arrive at an overall item score ranging from 0.00 to 1.00. So, for instance, if a particular hospital reported "How often did nurses communicate well with patients" survey results of always = 80%, sometimes = 15%, and never = 5%, the score for this survey item would be computed as follows:  $(80\% * 1.00) + (15\% * 0.6) + (5\% * .2) = 0.90$ . The weights applied to the response always, sometimes, and never are 1.00, 0.6, and 0.2, respectively. The weight of 0.2 for "never" responses was selected to provide a symmetrical distance (0.4) between each of the weights. This symmetry assures that no particular response group exerts a disproportionate effect on the overall measure. Each hospital within the sample is thus supplied with a score for each of the four survey items.

Table 2.1: Hospital Effectiveness Measure Summary

<b>Heart attack process of care best practice measures</b>	<b>Heart failure process of care best practice measures</b>	<b>Pneumonia process of care best practice measures</b>
Percent of Heart Attack Patients Given Aspirin at Arrival	Percent of Heart Failure Patients Given Discharge Instructions	Percent of Pneumonia Patients Assessed and Given Pneumococcal Vaccination
Percent of Heart Attack Patients Given Aspirin at Discharge	Percent of Heart Failure Patients Given an Evaluation of Left Ventricular Systolic (LVS) Function	Percent of Pneumonia Patients Whose Initial Emergency Room Blood Culture Was Performed Prior To The Administration Of The First Hospital Dose Of Antibiotics
Percent of Heart Attack Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)	Percent of Heart Failure Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)	Percent of Pneumonia Patients Given Smoking Cessation Advice/Counseling
Percent of Heart Attack Patients Given Smoking Cessation Advice/Counseling	Percent of Heart Failure Patients Given Smoking Cessation Advice/Counseling.	Percent of Pneumonia Patients Given Initial Antibiotic(s) within 6 Hours After Arrival
Percent of Heart Attack Patients Given Beta Blocker at Arrival		Percent of Pneumonia Patients Given the Most Appropriate Initial Antibiotic(s)
Percent of Heart Attack Patients Given Beta Blocker at Discharge		Percent of Pneumonia Patients Assessed and Given Influenza Vaccination
		Percent of Pneumonia Patients Given Oxygenation Assessment

These four items are then aggregated via simple averaging, yielding an overall measure of patient centeredness.

#### 2.4.2.2.4 Hospital Efficiency

A two-stage stochastic frontier analytical (SFA) analysis is used to determine the measure of hospital efficiency. Production data from the OSHPD are utilized to create a log normalized Cobb-Douglas production function. The Cobb-Douglas production function requires:

- a measure of production output, and
- measure(s) of production input.

The output measure (Y) for this analysis is the total number of discharges from the hospital within the year. This discharge figure includes all hospital discharges including nursery discharges. Production function inputs are:

- productive capacity (C)
- labor (L)
- capital (K)

Productive capacity is derived by summing the total number of available beds and bassinets within a hospital. Labor is derived via the total number of hospital full-time equivalent employees for the year. Capital is derived via net property, plant, and equipment. Control variables in the production function include; type of ownership (government, for profit, not-for-profit), emergency service offered (Y/N), and number of operating rooms within the hospital. Assuming a log-linear Cobb-Douglas form, the stochastic production function takes the form of:

$$\ln Y_i = \ln C_i + \ln L_i + \ln K_i + V_i + U_i$$

where:

$Y_i$  = the expected production output frontier given production function inputs (C,L,K)

$V_i + U_i$  = the extent to which the hospital deviates from this frontier

$V_i$  = random error (noise) components

$U_i$  = systemic technical efficiency (Coelli et al., 2005).

The SFA technical efficiency component produces the measure for efficiency used within this study.

Data Envelopment Analysis (DEA) is an alternative methodology for examining production frontiers and technical efficiencies. DEA was not selected for this study due to its limitation in separating and identifying the random error and systemic technical inefficiency components of the production function error (Greene, 2008; Kumbhakar & Lovell, 2000).

#### 2.4.2.2.5 Financial Performance

Financial performance for each hospital within the sample is determined via the California OSHPD database via the reported data elements, Total Operating Expense and Net Revenue from Operations. Operating Margin is derived as the ratio between Net Revenue from Operations and Total Operating Expense.

#### 2.4.3. Measure Summary

To provide an overview of this study's measures and from which data source they are derived, Table 2.2 is offered.

## 2.5. Analysis and Results

Little extant research has been found within the Operations Management literature examining the multidimensional determinants of the latent constructs hospital focus and hospital performance, and the effect of focus on performance within a healthcare context. An exception to this is case-based research conducted by Hyer et al. (2009) into operational, clinical, and financial performance in a focused hospital trauma care center. In examining research that has been conducted regarding firm performance as the dependent variable, an often-utilized analysis technique is that of canonical correlation analysis (CCA). Some Operations Management studies utilizing CCA include:

- an evaluation of corporate environmental management practices and firm performance (Montabon et al., 2007)
- a study of the relationship between human resource management practices and organizational performance (Ahmad & Schroeder, 2003)

Table 2.2: Measure / Data source Summary

Measure	Source	
	Hospital Compare Database (HCD)	California Office of Statewide Planning and Development Annual Financial Data 2008 database (OSHPD)
<b>Hospital Focus</b>		
Hospital Specialty Score (HSS)	x	
Number of General Lines of Service Within the Hospital	x	
Volume Levels Among Products	x	
Number of Specific Service Lines Exhibiting Procedure Activity	x	
<b>Hospital Performance</b>		
Safety	x	
Effectiveness	x	
Patient centeredness	x	
Efficiency	x	x
Financial performance		x



- research determining, and finding, causal relationships between multivariate constructs for quality including customer satisfaction, employee satisfaction, and employee service quality and organizational performance (Mandu et al., 1995)
- research exploring the impact of just-in-time manufacturing infrastructure on manufacturing performance (Sakakibara et al., 1997).

CCA is a member of the multivariate family of statistical techniques wherein the relationships between two sets of variables, one independent and another dependent, are tested. Montabon et al. (2007) provide a useful contrast between multiple regression techniques and CCS. They provide:

The canonical correlation determines what, if any, relationships exist between sets of variables. Multiple regression examines many-to-one relationships and allows the user to examine how much each variable contributes to the relationship. In contrast, canonical correlation examines many-to-many relationships; however it still allows the user to examine the contribution of individual variables. Each canonical function represents a many to many relationship and the contribution of each individual variable to a function is measured by the canonical loading. (p. 1008)

In this study, the sets of independent variables are comprised of observed indicators of hospital focus. The sets of dependent variables are comprised of observed indicators of hospital performance. The objective of this study is to test the relationship between these two sets of variables.

CCA is similar to factor analysis in that composites of the sets of independent and dependent variables which produce the highest degree of correlation between the independent and dependent variables under consideration are provided. Results of the CCA analysis will indicate the relationship between hospital focus and hospital

performance as well as the contribution of variables within each set to this relationship. Stata 10 was used for all CCA within this study.

### 2.5.1. Hospital Focus and Hospital Performance

Figure 2.5 provides a representation of the full canonical correlation between Hospital Focus and Hospital Performance, with all proposed indicator variables, was used to evaluate the hypothesized relationships between the sets of Hospital Focus and Hospital Performance variables.

To review, the research objectives of this study are:

- 1) to investigate the relationship between hospital focus and hospital performance,
- 2) to examine multidimensional measures for both the measure of hospital (service) focus and performance within the healthcare setting,
- 3) to investigate if the traditional positive relationships between focus and performance hold in the healthcare setting or if the negative relationship suggested by the first essay of this dissertation are indeed present using multidimensional measures.

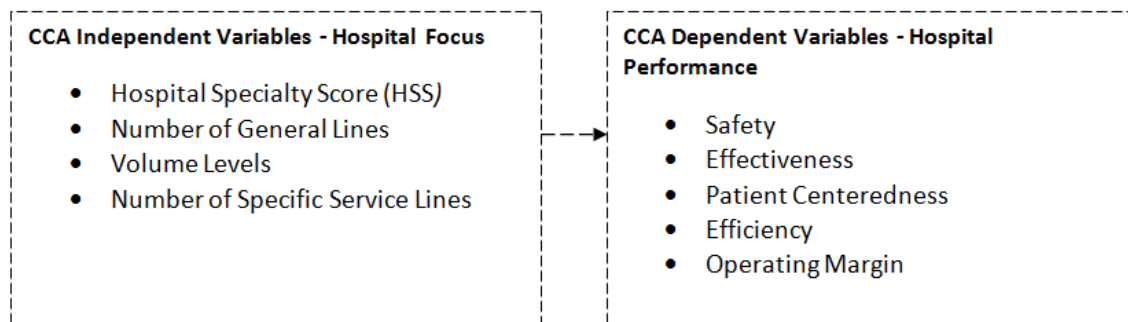


Figure 2.5: Canonical Correlation (CCA) Model for Focus – Performance Relationship

The CCA results in evaluating these research questions are discussed and summarized below.

#### 2.5.1.1. Hospital Focus / Hospital Performance Relationship

As CCA tests the significance of relationships between two sets of observed indicator variables, representing latent constructs, similar to exploratory factor analysis, the first test of the Focus / Performance relationship should determine if these two latent variables exhibit a significant linear relationship. This is tested through Wilks' lambda. For this statistic, the null hypothesis states that the two sets of variables (latent constructs) are not linearly related. For the Focus / Performance latent variables under consideration, Wilks' lambda is .6173 with 475.23 and 3.72 degrees of freedom with a  $p < 0.001$ . This statistic allows the rejection of the null hypothesis that the variables making up the Focus / Performance latent constructs are not linearly related. The latent variables Hospital Focus and Hospital Performance are significantly related as comprised of the hypothesized sets of indicator (observed) variables. The positive and significant relationship between the latent constructs Hospital Focus and Hospital Performance are to be interpreted as hospitals exhibiting a broader range of overall services (higher end of the Hospital Focus continuum) exhibit higher levels of overall performance.

#### 2.5.1.2. Multidimensional Measures of Hospital Focus and Hospital Performance

From the results above, we can now proceed to evaluate the multidimensional variables within these latent variables.

The canonical correlations shown in Table 2.3 are the Pearson correlation coefficients of the canonical variates for the indicator variable sets making up Focus and

Table 2.3: Tests of Canonical Functions

Function	Canonical Correlation	Multiple $F$	$df$ 1	$df$ 2	$p$
1	0.544	3.72	20	475.23	0.0000
2	0.296	1.62	12	381.28	0.0843
3	0.145	0.96	6	290	0.4512
4	0.135	1.35	2	146	0.2626

Performance, respectively. Tests of significance for the CCA, indicate that only the first canonical function of the four is statistically significant at the .05 level, although the second function is significant at the .10 ( $p = .0843$ ) level. The number of potential canonical functions corresponds to the lesser of the proposed canonical variates within Hospital Focus or Hospital Performance. The latent variable “Hospital Focus” is comprised of four (4) potential variates. Therefore CCA evaluates the significance of four canonical correlations. Function 1 has a canonical correlation of 0.544 between the sets of independent and dependent variables. As only the first set of canonical variates for Focus and Performance are significantly related at the .05 level, interpreting the significance of the Focus indicator variables on Performance is only practical using the first set of canonical loadings. Results of the significance of individual indicator variables within the individual canonical variates are presented in Table 2.4.

Examining the standardized canonical coefficients for the first canonical function provides the results summarized in Table 2.4. These standardized canonical coefficients are similar to factor loadings achieved in factor analysis techniques (Montabon et al., 2007). Only the first canonical function is significant at  $p < .05$ ; hence only the function variates for that function are of practical significance. In evaluating a multidimensional measure of Hospital Focus, CCA indicates that only two of four proposed observed variables, *Volume Levels Among Products* and *Number of Specific Service Lines* are

Table 2.4: Test of Variables Within Canonical Variates Focus and Performance

	1st Canonical Function*	2 <sup>nd</sup> Canonical Function**	3rd Canonical Function	4th Canonical Function
<b>Canonical Correlation</b>	0.544	0.296	0.145	0.135
<b>Test of residual correlation (<i>p</i> value)</b>	0.000	0.084	0.451	0.263
<b>Canonical Loading of Independent Variables – Hospital Focus</b>				
Hospital Specialty Score	0.402	-1.607*	2.381	0.960
General Lines of Service	-0.039	1.383*	0.594	0.037
Volume Levels Among Products	-0.329 *	-0.602	-0.020	-1.096
Num. Specific Lines Srvc.	0.756 *	0.947	-2.627	-0.707
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>				
Safety	0.264**	-0.856*	0.431	0.298
Effectiveness	0.041	0.258	0.962	-0.128
Patient Centeredness	0.644*	0.105	-0.636	-0.689
Efficiency	0.555*	0.236	-0.206	0.771
Financial Performance	0.086	0.283	0.143	0.007

\* $p < .05$ , \*\* $p < .10$

significant in the presence of all four proposed indicators. Of interest is the significance of independent indicator variables as others are dropped from the model.

In an effort to provide justification for dropping specific indicator variables, their correlations are analyzed and presented in Table 2.5.

As *Hospital Specialty Score* and *Number of Specific Lines of Service* are highly correlated, the CCA is repeated by omitting *Number of Specific Lines of Service* from the analysis. The results of this CCA are presented in Table 2.6. As only the first canonical function remains significant, results from this function are reported.

After removing *Number of Specific Lines of Service* from the CCA, *Hospital Specialty Score* exhibits significance while all other independent and dependent indicator variables maintain roughly similar levels of significance and magnitude. The interpretation of these results is covered in the Discussion section.

Table 2.5: Independent Indicator Variable Correlations

	Hospital Specialty Score	General Lines of Service	Volume Levels Among Products	Num. Specific Lines Service
Hospital Specialty Score	1.000			
General Lines of Service	0.667	1.000		
Volume Levels Among Products	0.501	0.623	1.000	
Num. Specific Lines Srvc.	0.946	0.647	0.481	1.000

Table 2.6: Retest of Variables within Canonical Variates Focus and Performance (w/ omission)

	1st Canonical Function*
<b>Canonical Correlation</b>	0.528
<b>Test of residual correlation (<i>p</i> value)</b>	0.000
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	1.151*
General Lines of Service	-0.053
Volume Levels among Products	-0.322**
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	0.346*
Effectiveness	0.082
Patient Centeredness	0.586*
Efficiency	0.538*
Financial Performance	0.078

\* $p < .05$ , \*\* $p < .10$

Referring to Table 2.4, and examining the latent dependent variate *Hospital Performance*, the indicator variables *Patient Centeredness* and *Efficiency* are significant at the .05 level with *Safety* significant at the .10 level. Other indicators of hospital performance, *Effectiveness* and *Financial Performance* are not significant. In evaluating how dependent indicator variables might behave in as others are excluded from the model, correlations between the separate dependent indicator variables are examined in Table 2.7.

Table 2.7: Dependent Indicator Variable Correlations

	Safety	Effectiveness	Patient Centeredness	Efficiency	Financial Performance
Safety	1.000				
Effectiveness	0.0752	1.000			
Patient Centeredness	0.3509	0.3573	1.000		
Efficiency	-0.0335	0.1460	0.0401	1.000	
Financial Performance	-0.0577	0.2943	0.2002	0.1139	1.000

As none of the dependent indicator variables show strong correlation, there is little justification for dropping any particular variable from the CCA.

The standardized canonical coefficients presented in Tables 2.4 and 2.6 define the linear relationship between indicator variables in a given dimension and the latent canonical variates *Hospital Focus* and *Hospital Performance* (Introduction to Stata, n.d.). They are interpreted the same as one would interpret regression coefficients, assuming the canonical variate as the outcome, dependent, variable. The interpretation of results is left for Section 6 – Discussion.

Several additional analyses have been performed which have been included in Appendix B – Supplemental Analyses. These analyses are not central to the research questions of this study, but do offer additional insights.

#### 2.5.1.3. A Final Note

It should be noted that these relationships does not suggest that the proposed focus and performance indicator variables are reliable measures of the constructs *Hospital Focus* and *Hospital Performance*. Cronbach’s alpha analysis was conducted for varying combinations of the each set of indicator variables. In no case did the alpha coefficient exceed the .70 threshold (Nunnaly, 1978).

## 2.6. Discussion

This research was motivated in large part by results obtained by the first essay of this dissertation which indicated that a one-dimensional measure of hospital focus (Hospital Specialty Score) is negatively related to both quality and efficiency in the healthcare environment. Interpreted, the results of this prior study suggest that hospitals exhibiting a broader range of services, i.e., lower focus, provide better overall care in terms of both quality (mortality and readmission rates) and efficiency.

The primary objective of this research is threefold:

- investigate the relationship between the latent construct Hospital Focus on Hospital Performance,
- examine multidimensional measures for both the measure of hospital (service) focus and performance within the healthcare setting,
- investigate if the traditional positive relationships between focus and performance hold in the healthcare setting or if the negative relationship suggested by within essay 1 are indeed present using multidimensional measures,

Utilizing canonical correlation analysis (CCA), individual canonical functions relating sets of hospital focus indicator variables (IVs) to sets of hospital performance indicator variables (DVs) were analyzed.

### 2.6.1.1. Relationships of the Measures of Hospital Focus on Hospital Performance

The CCA presented above provides the following results:



- The independent latent variable Hospital Focus is positively and significantly related to the dependent latent variable Hospital Performance. In this analysis, higher levels of Hospital Focus are indicative of facilities exhibiting a broader range of services. Hence, in a more general sense, hospital performance is enhanced within those facilities exhibiting a broader range of services. This general finding provides additional support, using a multidimensional approach, to the one-dimensional results obtained within the first essay of this dissertation.
- The Hospital Focus indicator variables *Volume Levels among Products* and *Number of Specific Lines of Service* are both significant. *Volume Levels among Products* contributes negatively to Focus. The *Number of Specific Lines of Service* contributes positively to Hospital Focus. Each of these indicator variables increases as the range of services within the hospital increases. However, *Volume Levels Among Products* increases as a hospital offers a large number of services (i.e., procedures) across a relatively few service lines. *Number of Specific Service Lines* increases simply as the total number of procedures increases at the hospital, regardless of relative levels. When omitting *Number of Specific Lines of Service* from the CCA, *Hospital Specialty Score* exhibits significant strong positive effect. Due to their strong positive correlation, *Hospital Specialty Score* and *Number of Specific Lines of Service* can be view as proxies for each other and should not be included simultaneously within the CCA.

- The observed variables *Patient Centeredness* and *Efficiency* each significantly and positively contribute to the latent variable *Hospital Performance*. As each of these indicator variables increases in value, the overall level of *Hospital Performance* is enhanced.
- Integrating the findings this study suggests a significant relationship between indicator variables for *Hospital Focus* and *Hospital Performance*. Specifically, the number of product, or service, lines (*Number of Specific Lines of Service* and *Hospital Specialty Score*) are positively related to the performance indicators *Patient Centeredness* and *Efficiency* and to a lesser degree *Safety*. These relationships support the findings of the first essay that as hospitals enhance their overall breadth of services (i.e., number of product lines) both efficiency and safety (outcome quality) are enhanced. Of interest in the significant negative relationship between *Volume Levels among Products* and *Patient Centeredness* and *Efficiency* and to a lesser degree *Safety*. This relationship supports the traditional relationship between focus and performance present in the academic literature. Hospitals exhibiting a broad range of services, but an emphasis on a particular line of services, might be well served to reduce emphasis on those services or procedures performed infrequently.

The first contribution of this study utilized multidimensional measures of focus and performance and suggested that hospitals exhibiting relatively broader ranges of services (i.e., lower focus) exhibit higher levels of overall performance. These results are consistent with the prior results suggested by the first essay of this dissertation. As

healthcare facilities broaden their range of services, overall performance is enhanced.

These results also suggest that the focus / performance relationships suggested within the manufacturing literature (Bozarth & Edwards, 1997; Brush & Karnani, 1996; Ketokivi & Jokinen, 2006; Mukherjee et al., 2000; Pesch & Schroeder, 1996; Skinner, 1974) are not entirely present within the healthcare sector.

As healthcare facilities expand their range of services (i.e., *decrease* operational focus), they concurrently are provided the opportunity to develop an expanding range of competencies. This enhancement of competencies provides the impetus to realize improvements key measures of performance. Should healthcare facilities wish to enhance performance measures of patient centeredness, efficiency, and safety; the results of this study suggest that an expansion of the range of services would provide desired improvements.

This study suggests also that facilities exhibiting a high degree of service variation exhibit a negative relationship to the performance indicators patient centeredness, efficiency, and quality. This finding is in line with the traditional focus / performance relationships. For optimal performance, it seems that hospitals might want to provide a relatively broad range of services without exhibiting a strong degree of variation within the selected range of services.

The positive narrow focus / higher performance relationship exists within manufacturing firms because of relatively larger investments in plant and equipment which are closely tied to their choice of manufacturing competence, or focus. Attempts to broaden the product-range, or decrease focus, are limited by existing plant infrastructure and managerial resources. This research suggests that hospitals, a major

component of the service sector, providing a broader range of services are able to exhibit enhanced performance. Services (i.e., hospitals) are more dependent upon labor, as opposed to a dependence upon fixed assets within manufacturing. This labor component is capable of developing and maintaining a broader range of core competencies, or a broader service offering, and provides significant competitive advantages, or enhanced performance (Heskett et al., 1997).

A potential explanation of these results may result from learning effects taking place as competencies are developed. Due to capital infrastructure limitations, manufacturing plants may be less capable of realizing these learning effects than service organizations. These learning effects find theoretical support in both the Resource Based View (RBV) (Barney, 1991; Wernerfelt, 1984) and Absorptive Capacity (AC) (Cohen & Levinthal, 1990) strategic theoretical frameworks. RBV posits that as firms develop resources or firm-specific capabilities that are valuable, unique, inimitable, and nonsubstitutable, real competitive advantage accrues to the organization. In the special case of healthcare facilities, the development of these resources occurs in order to enable the breadth of services to be increased, thereby providing enhanced healthcare quality, a type of competitive advantage. AC explains the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends. In the context of healthcare, as the range of services is expanded, the hospital (firm) is exposed to varying degrees of previously exogenous knowledge and capabilities. As this knowledge set is assimilated, enhanced healthcare delivery capabilities develop in the form of enhanced quality of outcomes and overall efficiencies. These resource development and knowledge assimilation activities are long-term in nature, providing further support for

the cumulative progression reasoning in developing both quality and efficiency capabilities within healthcare.

A developing research stream within the strategic management academy is that of Ambidextrous Organization's (AO) achieving superior performance. An AO is defined as one that, "(is) capable of simultaneously exploiting existing competencies and exploring new opportunities" (Raisch et al., 2009, p. 685). Hospitals exhibiting a broad range of services can be thought of as being ambidextrous and capable of exploiting existing competencies while also exploring new opportunities.

The level of customer contact might also explain the focus / performance relationship within the hospital service sector (Duclos et al., 1994). Customers (patients) exhibit a broad range of conditions requiring a broad range of service expertise. Hospitals not able to respond to this broad spectrum of customer requirements will not be in position to perform as well as those that are able to do so.

It is interesting to note that there is at least a degree of support to the traditional manufacturing focus relationship to performance within this study. *Volume Levels Among Products* shows a significant, negative relationship to Focus and by extension to Performance. Hospitals seem to exhibit the same relationship to variation among products / service that manufacturing firms exhibit. A product / service offering that shows wide variations among its volume level is detrimental to performance in both the manufacturing and service sector.

Of particular interest in this study is the relationship between the focus indicators, *Number of Specific Lines of Service* and *Hospital Specialty Score*. These two indicators exhibit a strong positive correlation. Because of this relationship, the finding of essay 1

that hospitals exhibiting a broad range of services also providing enhanced quality outcomes is additionally supported, regardless of the indicator variable deployed. The findings from the four-, and three-variable focus CCA (Tables 2.4 and 2.6) are congruent.

The second contribution of this study seeks to understand the contribution of multidimensional sets of focus / performance measures. Among the four proposed variables contributing to Hospital Focus, *Volume Levels Among Products* and *Number of Specific Lines of Service / Hospital Specialty Score* were found to significantly contribute to Hospital Focus. However, these variables contribute to Hospital Focus and by extension Hospital Performance in a converse fashion. Hospitals exhibiting a relatively large number of procedure activities within a narrow range of general lines of service (*Volume Levels Among Products*) exhibit a higher degree of focus and detract from overall performance. Conversely, as the number of specific lines of service increase (*Number of Specific Service Lines / Hospital Specialty Score*), or a decrease in focus, overall performance is enhanced. This finding provides evidence of the utility of a multidimensional evaluation of the construct Hospital Focus (Hyer et al., 2009). Using a one dimensional evaluation, the first essay of this dissertation suggested that broader ranges of services contribute to enhanced performance in terms of both quality and efficiency. Using a multidimensional approach, we are able to gain further insights into the Focus / Performance relationship.

The final contribution of this study provides insights as to which indicators of performance are significant within the proposed focus/ performance framework. The study finds *Patient Centeredness*, *Efficiency* and to a lesser extent *Safety* are significant indicators of enhanced performance in the presence of the indicators of focus used within

this study. Of particular interest is the lack of support in financial performance contributing to performance within the healthcare setting. This lack of relationship between financial performance and indicators of hospital focus is reinforced by subsequent regression analysis. This analysis indicates that *none* of the indicators of hospital focus are significant predictors of financial performance.

## 2.7. Conclusions and Limitations

This study provides one of the first empirically-driven, cross-sectional examinations of multidimensional relationships between hospital focus and performance. Both focus and performance are found to be multidimensional in nature, in support of previous research (Hyer et al., 2009; Pesch & Schroeder, 1996). Prior research highlighting the differences between the manufacturing focus and healthcare focus effects on performance measures are highlighted. The findings of this study serve as impetus for further examinations of this relationship utilizing a broader set of hospital focus measures, a limitation of this study. In expanding on this initial, largely exploratory study, future confirmatory studies should attempt to identify focus measures in terms which capture the definition of competitive priorities, competitive priority and business strategy congruency, decision making consistency, and compatibility of hospital resources across various product (procedure) groupings (Pesch & Schroeder, 1996).

This line of inquiry would also benefit from the use of additional analytical methods. The canonical correlation analysis methods used in this study are largely exploratory in nature and offer little in terms of explanatory effect (Montabon et al., 2007). Potential explanatory methods would include confirmatory factor analyses or

structural equation modeling. By introducing additional measures of focus and performance, the power of these explanatory techniques would likely be enhanced.

Per Appendix B - Supplemental Analysis, for profit and not-for-profit hospitals have been shown to exhibit a positive relationship with the performance indicator variables *Safety, Efficiency, and Patient Centeredness*. This relationship suggests that nongovernment owned hospitals perform better than government-owned hospitals in the presence of focus indicator variables. This relationship warrants further investigation.

This exploratory study examines hospital performance throughout California, without regard to geographic differences. A fruitful research endeavor would be to examine the focus / performance differences across varying hospital geographies and demographics such as urban versus rural, high versus low income population centers, and the relative age of the population served.



## 2.8. Appendix A - Risk-adjusted Mortality and Readmission

Quoted directly from:

U.S. Department of Health and Human Services, Hospital Compare Database website (<http://www.hospitalcompare.hhs.gov/staticpages/for-professionals/ooc/statistical-methods.aspx>)

### Statistical Methods Used to Calculate Rates - Mortality Measures

#### Hierarchical Regression Model

The statistical model for computing 30-day risk-adjusted mortality rate measures is a "hierarchical regression model." This type of model is based on the assumption that any heart attack or heart failure or pneumonia patients treated at a particular hospital will experience a level of quality of care that applies to all patients treated for the same condition in that hospital. In other words, the expected risk of death for two similar heart attack or heart failure or pneumonia patients treated in the same hospital would be more alike than the risk of death for the same two patients treated in two different hospitals. The likelihood that an individual patient will die is therefore a combination of:

- his or her individual risk characteristics (for example, gender, comorbidities, and past medical history) and
- the hospital's unique quality of care for all patients treated for that condition in that hospital.

The model estimates the effects of both of these components on mortality.

#### Calculating Mortality Rates

Each hospital's "30-day risk-adjusted mortality rate" (also called the "Risk Standardized Mortality Rate" or RSMR) is computed in several steps. First, the *predicted* 30-day mortality for a particular hospital obtained from the hierarchical regression model is divided by the *expected* mortality for that hospital, which is also obtained from the regression model. Predicted mortality is the rate of deaths from heart attack or heart failure or pneumonia that would be anticipated in the particular hospital during the 12-month period, given the patient case mix and the hospital's unique quality of care effect on mortality. Expected mortality is the rate of deaths from heart attack or heart failure or pneumonia that would be expected if the same patients with the same characteristics had instead been treated at an "average" hospital, given the "average" hospital's quality of care effect on mortality for patients with that condition. This ratio is then multiplied by the national unadjusted mortality rate for the condition for all hospitals to compute a "risk-adjusted mortality rate" for the hospital. So, the higher a hospital's predicted 30-day mortality rate, relative to expected mortality for the hospital's particular case mix of patients, the higher its adjusted mortality rate will be. Hospitals with better quality will have lower rates.

$(\text{Predicted 30-day mortality} / \text{Expected mortality}) * \text{U.S. National mortality rate} = \text{RSMR}$

## Statistical Methods Used to Calculate Rates - Readmission Measures

### Hierarchical Regression Model

The statistical model for computing the 30-day risk-standardized readmission rates is a "hierarchical regression model." This type of model is based on the assumption that any heart attack, heart failure, or pneumonia patient treated at a particular hospital will experience a level of quality of care that applies to all patients treated for the same condition in that hospital. In other words, the expected risk of readmission for two similar heart attack, heart failure, or pneumonia patients treated in the same hospital would be more alike than the risk of readmission for the same two patients treated in two different hospitals. The likelihood that an individual patient will be readmitted is therefore a combination of:

- his or her individual risk characteristics (for example, gender, comorbidities, and past medical history) and
- the hospital's unique quality of care for all patients treated for that condition in that hospital.

The model estimates the effects of both of these components on on risk of readmission.

### Calculating Readmission Rates

Each hospital's 30-day risk-standardized readmission rate (RSRR) is computed in several steps. First, the predicted 30-day readmission for a particular hospital obtained from the hierarchical regression model is divided by the expected readmission for that hospital, which is also obtained from the regression model. Predicted readmission is the number of readmissions (following discharge for heart attack, heart failure, or pneumonia) that would be anticipated in the particular hospital during the study period, given the patient case mix and the hospital's unique quality of care effect on readmission. Expected readmission is the number of readmissions (following discharge for heart attack, heart failure, or pneumonia) that would be expected if the same patients with the same characteristics had instead been treated at an "average" hospital, given the "average" hospital's quality of care effect on readmission for patients with that condition. This ratio is then multiplied by the national unadjusted readmission rate for the condition for all hospitals to compute an RSRR for the hospital. So, the higher a hospital's predicted 30-day readmission rate, relative to expected readmission for the hospital's particular case mix of patients, the higher its adjusted readmission rate will be. Hospitals with better quality will have lower rates.

$(\text{Predicted 30-day readmission} / \text{Expected readmission}) * \text{U.S. National readmission rate} = \text{RSRR}$

## 2.9. Appendix B – Supplemental Analyses

Tables 2.8 – 2.14 provide additional Canonical Correlation Analyses wherein the inclusion / exclusion of specific canonical variates are explored.

Table 2.8: Test of Variables Within Canonical Variates Focus and Performance – Significant Indicator Variables from Table 2.4 Included

	<b>1st Canonical Function*</b>
<b>Canonical Correlation</b>	0.537
<b>Test of residual correlation (<i>p</i> value)</b>	0.000
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	
General Lines of Service	
Volume Levels among Products	-0.328*
Num. Specific Lines Srvc.	1.116 *
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	0.202
Effectiveness	
Patient Centeredness	0.707*
Efficiency	0.578*
Financial Performance	

\* $p < .05$ , \*\* $p < .10$

Stata command lines:

- `. canon (var_prop_neg num_drg) (quality_1_h pt_rec_hosp efficiency), stdcoef test (1,2)`
- `. canon (var_prop_neg num_drg) (quality_1_h pt_rec_hosp efficiency), stderr test (1,2)`

Results are similar to original full CCA model. This supports the dominance of the breadth of services effect over service volume variation found in the full CCA model.

Table 2.9: Test of Variables Within Canonical Variates Focus and Performance – Significant Indicator Variables from Table 2.4 Included (Swap Specialty Score with Number Specific Lines of Service)

	<b>1st Canonical Function*</b>
<b>Canonical Correlation</b>	0.524
<b>Test of residual correlation (<i>p</i> value)</b>	0.000
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	1.129*
General Lines of Service	
Volume Levels among Products	-0.352*
Num. Specific Lines Srvc.	
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	0.319*
Effectiveness	
Patient Centeredness	0.644*
Efficiency	0.568*
Financial Performance	

\* $p < .05$ , \*\* $p < .10$

Stata command lines:

- `. canon (spec_score var_prop_neg) (quality_1_h pt_rec_hosp efficiency),  
stderr test (1,2)`
- `. canon (spec_score var_prop_neg) (quality_1_h pt_rec_hosp efficiency),  
stdcoef test (1,2)`

Specialty score provides roughly same effect as Number of Specific Lines of

Service

Table 2.10: Test of Variables Within Canonical Variates Focus and Performance – Significant Indicator Variables from Table 2.4 Included (Include Specialty Score and Number Specific Lines of Service)

	<b>1st Canonical Function*</b>
<b>Canonical Correlation</b>	0.541
<b>Test of residual correlation (<i>p</i> value)</b>	0.000
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	0.359
General Lines of Service	
Volume Levels among Products	-0.349*
Num. Specific Lines Srvc.	0.780*
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	0.238**
Effectiveness	
Patient Centeredness	0.688*
Efficiency	0.577*
Financial Performance	

\* $p < .05$ , \*\* $p < .10$

Stata command lines:

- `. canon (spec_score var_prop_neg num_drg) (quality_1_h pt_rec_hosp efficiency), stderr test (1,2)`
- `. canon (spec_score var_prop_neg num_drg) (quality_1_h pt_rec_hosp efficiency), stdcoef test (1,2)`

Similar results as with full CCA.

Table 2.11: Test of Variables Within Canonical Variates Focus and Performance – Non Significant Indicator Variables from Table 2.4 Included

	<b>1st Canonical Function*</b>
<b>Canonical Correlation</b>	0.2751
<b>Test of residual correlation (<i>p</i> value)</b>	0.018
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	0.447
General Lines of Service	0.644**
Volume Levels among Products	
Num. Specific Lines Srvc.	
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	
Effectiveness	0.809*
Patient Centeredness	
Efficiency	
Financial Performance	0.396

\* $p < .05$ , \*\* $p < .10$

Stata command lines:

- `. canon (spec_score prod_lines) (avg_all tot_mrg), stderr test (1,2)`
- `. canon (spec_score prod_lines) (avg_all tot_mrg), stdcoef test (1,2)`

Two indicator variables found to be significant at least at  $p < .10$ . Per iterative method in Montabon et al. (2007), include significant indicator variables from this model in CCA model depicted in Table 2.8.

Table 2.12: Test of Variables Within Canonical Variates Focus and Performance – Significant Indicator Variables from Table 2.11 Included in Table 2.8 Model

	<b>1st Canonical Function*</b>
<b>Canonical Correlation</b>	0.538
<b>Test of residual correlation (<i>p</i> value)</b>	0.000
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	
General Lines of Service	-0.003
Volume Levels among Products	-0.323**
Num. Specific Lines Srvc.	1.116*
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	0.205
Effectiveness	0.048
Patient Centeredness	0.689*
Efficiency	0.570*
Financial Performance	

\* $p < .05$ , \*\* $p < .10$

Stata command lines:

- `. canon (prod_lines var_prop_neg num_drg) (quality_1_h avg_all pt_rec_hosp efficiency), stderr test (1,2,3)`
- `. canon (prod_lines var_prop_neg num_drg) (quality_1_h avg_all pt_rec_hosp efficiency), stdcoef test (1,2,3)`

Per iterative method in Montabon et al. (2007), include significant indicator variables from model in Table 2.11 CCA model depicted in Table 2.8. Results from this iterative model are similar to full CCA.

Table 2.13: Test of Variables Within Canonical Variates Focus and Performance – Introduce Control Variables from Essay 1

	<b>1st Canonical Function*</b>
<b>Canonical Correlation</b>	0.628
<b>Test of residual correlation (<i>p</i> value)</b>	0.000
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	0.582**
General Lines of Service	-0.067
Volume Levels among Products	-0.279*
Num. Specific Lines Srvc.	0.391
<b>Canonical Loading of Independent Control Variables – Hospital Focus</b>	
Ownership (For Profit)	0.426*
Ownership (Non profit)	0.660*
Emergency Service	-0.146
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	0.279*
Effectiveness	0.097
Patient Centeredness	0.589*
Efficiency	0.631*
Financial Performance	-0.097

\* $p < .05$ , \*\* $p < .10$

Stata command lines:

- `. canon (spec_score prod_lines var_prop_neg num_drg ownership_prop2 ownership_np3 emergencyservice) (quality_1_h avg_all pt_rec_hosp efficiency tot_mrg), stdcoef test(1,2,3, 4)`
- `. canon (spec_score prod_lines var_prop_neg num_drg ownership_prop2 ownership_np3 emergencyservice) (quality_1_h avg_all pt_rec_hosp efficiency tot_mrg), stderr test(1,2,3,4)`

By introducing independent control variables, the relationships between the indicator variables for focus and performance maintain roughly the same relationships. The primary difference is that the relationship of the *Number of Specific Lines of Service* loses significance. However, it has been established that *Specialty Score* and *Number of Specific Lines of Service* are roughly identical proxies for the total number of product lines. Hospital specialty score is significant at the .10 level.



Results from this CCA roughly mirror the results from the full CCA model and the Drivers of Quality and Efficiency linear regression models from essay 1.

Table 2.14: Test of Variables Within Canonical Variates Focus and Performance – Introduce Control Variables from Essay 1, Remove Number of Specific Lines of Service

	<b>1st Canonical Function*</b>
<b>Canonical Correlation</b>	0.623
<b>Test of residual correlation (<i>p</i> value)</b>	0.000
<b>Canonical Loading of Independent Variables – Hospital Focus</b>	
Hospital Specialty Score	0.958*
General Lines of Service	-0.068
Volume Levels among Products	-0.278*
Num. Specific Lines Srvc.	---
<b>Canonical Loading of Independent Control Variables – Hospital Focus</b>	
Ownership (For Profit)	0.476*
Ownership (Non profit)	0.690*
Emergency Service	-0.156
<b>Canonical Loading of Dependent Variables – Hospital Performance</b>	
Safety	0.316*
Effectiveness	0.110
Patient Centeredness	0.549*
Efficiency	0.641*
Financial Performance	-0.101

\* $p < .05$ , \*\* $p < .10$

Stata command lines:

- `. canon (spec_score prod_lines var_prop_neg ownership_prop2 ownership_np3 emergencyservice) (quality_1_h avg_all pt_rec_hosp efficiency tot_mrg), stdcoef test(1,2,3, 4)`
- `. canon (spec_score prod_lines var_prop_neg ownership_prop2 ownership_np3 emergencyservice) (quality_1_h avg_all pt_rec_hosp efficiency tot_mrg), stderr test(1,2,3,4)`

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## CHAPTER 3

### COMPETITIVE CAPABILITIES: A HEALTHCARE PERSPECTIVE

#### 3.1. Introduction

Operations strategy research often delves into the definition of competitive capabilities and the process of how firms develop these capabilities. Two of the most common strategic competitive capability frameworks are the trade-off perspective and the cumulative progression perspective. A recent overview of operations strategy research identified the trade-off / cumulative progression question to be among the most-often researched theoretical perspectives (Boyer, Swink & Rosenzweig, 2005). Most of this prior research is focused on the manufacturing environment and has consistently identified four primary competitive priority constructs: quality, reliability, flexibility, and cost efficiency. Depending on the research, these constructs are thought to be acquired in a trade-off, i.e., one at the cost of another (Garvin, 1993; Hayes & Wheelwright, 1984; Hill, 1994; Mapes et al., 1997; Skinner, 1969, 1974), or in a cumulative, i.e., simultaneous, fashion (Ferdows & DeMeyer, 1990; Narasimhan, Swink & Kim, 2005; Schonberger, 1990; Szejczewski, Mapes & New, 1997). There is also research suggesting these two frameworks exhibit an integrated, or hybrid, relationship based on a firm's unique operating characteristics (Boyer & Lewis, 2002; Rosenzweig & Roth, 2004; Schmenner & Swink, 1998). Based on this past research, it is apparent that the



question of firms' acquisition of competitive capabilities in a trade-off, cumulative, or integrative fashion is worthy of further research.

Most extant research regarding these relationships has been focused within the manufacturing sector. Some research has also been conducted addressing the fashion whereby service organizations acquire competitive capabilities. Hill et al. (2002) suggested a research agenda for examining trade-off versus competitive progression within the retail and e-tail service sectors. Wang and Masini (2010) investigate the relevance of the competitive progression theory within U.K. vehicle repair industry and find general support for that theory, with the exception that the development of the flexibility capability relative to quality, delivery, and cost is more complex than hypothesized in the fundamental theory. Research within the banking industry has shown a link between service quality and four generic capabilities (Roth & Jackson, 1995). While these generic capabilities do not correspond to those within the capability progression framework, this study does support the notion that service quality is enhanced by the presence of multiple competitive capabilities. Another banking industry study indicates that overall service quality is enhanced by banks exhibiting greater degrees of operational efficiency (Soteriou & Zenios, 1999). While not addressing competitive progression or trade-off specifically, this banking industry study does show a positive relationship between service quality and operational efficiency, both key competitive capabilities.

Healthcare is a key contributor to total services within the U.S. economy. In 2002, the service sector comprised approximately 80% of total U.S. GDP (CIA World Factbook, 2004). In 1960, healthcare spending comprised 4.7% of U.S. GDP and grew to

14.9% of GDP in 2005. (Congressional Budget Office, 2007). By the mid-2000s the healthcare sector comprised almost 20% of U.S. economy's service sector. This research specifically investigates the hospital industry as a key component of the service sector (Lim & Tang, 2000).

Building on previous research in trade-off versus competitive progression within the manufacturing and service sectors, this research attempts to:

- 1) further research the trade-off versus competitive progression frameworks of competitive capability acquisition
- 2) extend this research into the service (i.e., hospital) sector

The purpose of this research then is to:

- 1) provide a framework for evaluating the acquisition of capabilities within the healthcare service sector
- 2) determine, in an exploratory fashion, if individual hospitals with specific performance characteristics acquire competitive capabilities in a trade-off, cumulative, or integrative fashion.

Data from over 140 California hospitals over two time periods are analyzed to evaluate the research questions within this study.

The remainder of this study is organized as follows: Section 2 provides a review of the literature, Section 3 conceptually develops the proposed hypotheses, Section 4 summarizes data sources and measures used within the study, Section 5 provides a summary of the empirical analyses and results, Section 6 presents a discussion of the results and Section 7 provides conclusions and an overview of future directions for this research stream.

### 3.2. Literature Review

This section provides an overview of the academic literature addressing both Capability Trade-off Theory and Competitive Progression Theory (CPT).

#### 3.2.1. Capability Trade-off Theory

Skinner (1969, 1974) was among the first to suggest that managers of manufacturing firms are best served by selecting a competitive priority or competence and then designing the firm's systems around that selected priority. One of Skinner's main tenets was that plants should focus on a single competitive priority and design their systems around this priority. This focus stems from the thinking that differing competitive priorities require very separate and distinct support structures and that focusing on more than a single competitive priority will introduce inconsistencies among the various manufacturing support structures required to run a successful organization. This emphasis on focusing on a single competitive priority gave rise to the "focused factory" concept, attributed largely to Skinner's initial conceptual work. Hayes and Wheelwright (1984) offered further support for the focused manufacturing concept. They went so far as to suggest that it is "potentially dangerous" for organizations to seek "superior performance" among several competitive dimensions. One of the frequently cited "trade-offs" is that between low cost and high flexibility (Garvin, 1993; Hayes & Wheelwright, 1984; Hill, 1994). In a survey of managers and operators in 110 plants that implemented advanced manufacturing technologies, Boyer and Lewis (2002) provided evidence that trade-offs between quality, delivery, flexibility, and cost priorities exist. They also found, however, that multiple competitive priorities are considered

essential to competitive success, but that in practice decision makers do indeed focus on a single competitive priority within their overall decision making activities.

Some studies provide empirical support for the trade-off of manufacturing capabilities. Mapes et al. (1997) provided empirical evidence via a sample of over 700 UK manufacturing plants that trade-offs exist among plants that exhibit a larger range of products. This can be interpreted as plants providing a relatively wide product breadth need to choose among a relatively small set of competitive priorities upon which they will focus. Squire et al. (2009) provide support via a survey of 109 UK manufacturing firms seeking mass customization that competitive trade-offs do exist between the competitive capabilities; manufacturing cost and delivery lead-time. Conversely, they also found significant compatibility between quality, volume flexibility, delivery reliability and nonmanufacturing costs for the same firms. This indicates that the question of trade-off versus competitive progression is not an either-or proposition. Lapre and Scudder (2004) provided evidence that U.S. airlines operating close to their asset frontiers (combinations of company investment in plant and equipment) and by extension their performance frontier, are subject to trade-offs in the competitive decisions they make. A detailed discussion of performance frontiers follows later in this essay. The notion of where a firm operates in relation to other, similar firms, on specific performance characteristics is central to the research conducted within this study.

Some research has focused on the trade-off question within the service industry. Frei (2006) examines a broad spectrum of service industries and recommends optimal capability trade-off strategies in servicing a broad spectrum of client types and abilities. Research in the fast-food service industry suggests a trade-off relationship between two

generalized groups of capabilities, operational and relational. Operational capabilities relate to “product availability, product condition, delivery reliability, and delivery speed.” Relational capabilities consist of communications and responsiveness. These capabilities exhibit a high-low or low-high relationship to superior customer satisfaction (Zhao & Stank, 2003). This service industry-focused research largely parallels that of earlier research within the manufacturing sector.

This research seeks to expand this research in service operations performance and competitive capability trade-offs into the healthcare space.

### 3.2.2. Competitive Progression Theory (CPT)

As a result of questioning the validity of trade-offs between competitive priorities, Strategy and Operations researchers introduced the notion that firms should optimally pursue a progression of capabilities over time so as to enhance overall competitive performance. This progression supposed that capabilities acquired at one point in time would continue to exist and be improved while additional capabilities were acquired and improved. One of the main drivers of this line of thought is that modern organizations cannot afford to optimize performance along a single trajectory (i.e., quality, flexibility, delivery reliability, and cost) and that parallel improvements along these trajectories reinforce one another (Schonberger, 1990; Szwejczewski, Mapes & New, 1997).

Another argument for establishing competitive priorities in a cumulative fashion relies on the notion that newly developed and implemented manufacturing technologies enable plants to develop capabilities cumulatively (Corbett & VanWassenhove, 1993) in a fashion that earlier organizations, utilizing prior technologies, were not able to pursue.

Among the first researchers to give form to the idea of acquiring competitive capabilities

in a cumulative fashion were Nakane (1986) and Ferdows and DeMeyer (1990). Nakane suggested that Japanese manufacturing firms followed a quality, delivery dependability, cost efficiency, and flexibility competitive progression order. Ferdows and DeMeyer proposed what they termed a “sand cone” model in which plants would acquire and maintain capabilities in a sequential fashion. In order, from first to last, these capabilities are high quality, dependable production processes, speed of production, and cost efficiency. Key to this framework is the idea that these capabilities are acquired in the order specified above, and that as subsequent capabilities are developed, previously acquired capabilities continue to be enhanced and enlarged. Within this relative ordering framework, capabilities acquired earlier can be thought of as being “foundational” while those acquired later on can be thought of as being “secondary” in nature. This continual acquisition and enhancement of foundational capabilities while secondary capabilities are added / enhanced gives rise to the “sand cone” metaphor. One of the critiques of this initial research was its lack of empirical support. Limited empirical support that high-performing plants compete on multiple dimensions was provided by Roth and Miller (1992) and Noble (1995). Utilizing cluster analysis on 58 U.S. plants, Narasimhan, Swink and Kim (2005) provide evidence of a “progression of capabilities linked to specific performance gains” (p. 1013). Noble (1997) investigated 561 firms worldwide and their adoption of simultaneous competitive priorities. The research found that better performing firms are able to develop competitive capabilities in a cumulative fashion. Additionally, those firms that developed capabilities in a cumulative fashion also showed more clearly defined competitive strategies. The cumulative effects among specific strategic capabilities have also been studied. Using structural equation modeling, quality

has been shown as a basis, or foundation, for delivery, which in turn serves as a basis for both flexibility and cost. A limited relationship between flexibility and cost has been found (Größler & Grübner, 2006).

Flynn and Flynn (2004) examined the nature of cumulative capabilities of world-class-manufacturers in several countries. They found a direct relationship between cumulative capabilities and plant performance. They also found evidence that patterns of cumulative capabilities exist within specific countries but found little support for the more specific “sand cone” form of capability progression.

Wang and Masini (2010) specifically examined competitive progression theory within a service context - the U.K. vehicle repair industry. Their study examines whether the acquisition of a specific capability enhances or detracts from existing capabilities. CPT holds that existing capabilities should not be adversely impacted by the acquisition of new capabilities. In many cases, they should, in fact, be enhanced. Their research suggests that while quality (a base-line or foundational capability) remains unaltered, cost and delivery capabilities (relative secondary capabilities) exhibit a trade-off relationship, when acquiring flexibility capabilities. These findings, wherein a foundational capability exhibits no enhancement as secondary capabilities are acquired, seem to refute CPT in general.

Within the retail banking industry, empirical evidence has been provided suggesting that particularly well-performing banks exhibit the ability to perform well across multiple operations capabilities (Menor et al., 2002).

A study of ERP implementations (a product / service hybrid) suggests that initial benefits accrue to the implementing organization in terms of internal process

improvements and then to external “market and supply chain performance” (Stratman, 2007). This progression from internal to external market and supply chain enhancements is representative of the progression of capabilities theorized within the competitive progression framework.

Within a manufacturing competitive progression context, a common theme seems to be that capabilities are acquired in a particular order. Ferdows and DeMeyer (1990), citing previous manufacturing research, maintain that quality and cost efficiency improvements are not mutually exclusive and that cost efficiency gains would occur as a result of prior gains in quality. This question of the order and magnitude of competitive capability acquisition, applied specifically to the service sector, is a central focus of this research.

### 3.2.3. Linkages Between Trade-off and Competitive Progression Theories

Some research has been conducted in an effort to identify linkages between the trade-off and competitive progression views of capability acquisition. Boyer and Lewis (2002) provide evidence of an “integrative” model. They find, via a specifically-designed survey, that manufacturing plants do make trade-offs among competitive priorities but that plant managers also consider the four manufacturing capabilities suggested by Ferdows and DeMeyer (1990) to be vital for overall manufacturing success. Plants were found to focus on specific competitive priorities, mainly due to mind-share limitations of managers, even in the presence of advanced manufacturing technologies. Schmenner and Swink (1998) suggest that the trade-off and competitive perspectives are complementary in nature. They are complementary on two fronts: first, trade-offs occur in real-time while competitive progression occurs via improvements over



a longer time-frame. Second, they relate both perspectives in terms of an asset frontier. Firms nearing the limits of performance dictated by their asset frontier are more likely to pursue a trade-off trajectory, while those further away from the frontier will be more likely to pursue a competitive progression trajectory. Rosenzweig and Roth (2004) summarize that manufacturing organizations operating near their performance frontier are more likely to pursue a trade-off trajectory, while those lying more distant from the performance frontier will utilize a competitive progression framework. They define the performance, or production, frontier as, “the maximum performance that can be achieved by a manufacturing unit, given a set of operating choices” (pp. 355-356). This definition of a performance frontier will be utilized within this research and will form the basis for evaluating trade-off versus competitive progression positioning. Specifically, the “set of operating choices” for this examination of performance frontiers will be quality and cost efficiency, both key competitive capabilities within the larger trade-off versus competitive progression framework.

### 3.3. Conceptual Development

This section will develop proposed relationships between key competitive capabilities within the hospital services industry. Prior literature has identified three potential frameworks of developing competitive capabilities. These are:

- *Trade-off*: Firms develop and select capabilities in a singular fashion, selecting that capability which best suits the unique resources of the firm (Boyer & Lewis, 2002; Garvin, 1993; Hayes & Wheelwright, 1984; Hill, 1994).

- *Competitive progression*: Competitive capabilities are acquired in a sequential fashion. Previously acquired or developed foundational capabilities are consistently enhanced as new capabilities are developed. An oft-cited expression of this framework is the “sand cone” model put forth by Ferdows and DeMeyer (1990). This model theorizes that the competitive capabilities of quality, dependability, speed, and cost efficiency are acquired in that order and continually enhanced as additional capabilities are enhanced.
- *Integrated framework*: Some operations management researchers have found merit in both the trade-off and competitive progression frameworks. These frameworks would apply to firms, depending upon where they currently reside in relation to a performance frontier, referred to alternatively as an asset, operational, or performance frontier (Boyer & Lewis, 2002; Schmenner & Swink, 1998).

This exploratory research will identify the applicability of these frameworks via a sampling of over 140 California hospitals during two time periods; 2005-08 and 2006-09.

### 3.3.1. Choice of Competitive Priorities

Within the body of competitive capability research, quality, dependability, speed, and cost efficiency are often identified as key capabilities (Ferdows & DeMeyer, 1990; Nakane, 1986). This study investigates two of these capabilities which often reside and the extremes of capability acquisition ordering, quality and cost efficiency, and determines which of the competitive capability frameworks most appropriately applies to the hospital service sector.

Cost efficiency is often cited as a key competitive capability. Within healthcare industry research, cost and efficiency have been interchanged and equated (Carey, 2003; Vitaliano & Toren, 1994). This research will utilize a measure of hospital efficiency, a key competitive priority, determined via stochastic frontier analysis techniques.

There are many domains of quality within hospitals (e.g., outcome, process, organizational, etc.) (Rubin et al., 2001). Outcome quality measures are appropriate for a study of this type due to their close association with traditional operations management measures of quality, including failure rates (mortality) and rework rates (readmission). The healthcare literature also frequently uses outcome measures as indicators of overall quality (Davies & Crombie, 1995; Isaac & Jha, 2008). Outcome quality, measured by risk-adjusted mortality and readmission rates, forms the basis for evaluating quality throughout this study.

Quality and cost efficiency are then the two competitive capabilities evaluated within this study due to;

- 1) their ubiquity in extant research pertaining to competitive capabilities
- 2) their close association with overall performance within the healthcare industry.

### 3.3.2. Performance Frontiers

Performance frontiers have been used extensively by healthcare and business researchers to identify organizations which most efficiently utilize resources to achieve desired outcomes (Bendoly, Rosenzweig & Stratman, 2009; Benneyan, Sunnetci & Ceyhan, 2008; Clark, 1996; Schmenner & Swink, 1998; Vastag, 2000).

Economic theory provides a definition of performance frontiers. Samuleson (1947) suggests that, given technical considerations, production frontiers produce a maximum output from a set of inputs. Schmenner and Swink (1998) offer an operations-centric definition of performance frontiers, namely, “the maximum performance that can be achieved by a manufacturing unit, given a set of operating choices” (p.108). This “point-in-time” definition is expanded by Vastag (2000) to suggest that a firm’s, and even an industry’s, performance frontier will change over time as new technologies and / or operating choices are introduced. Within an Operations Management context, performance frontiers have also been framed in terms of the strategic choices regarding enterprise system information utilization (Bendoly, Rosenzweig & Stratman, 2009). These authors identify three strategic choices, operational excellence, customer intimacy and product leadership. Firms which utilize enterprise system information in singular accordance with one of these choices are found to exhibit superior performance.

This study borrows from the performance frontier concept to analyze the relative movement of quality and efficiency measures over two time periods (2005-08, 2006-09). The performance frontier of this study will be comprised of those hospitals exhibiting the highest levels of both efficiency (operating choices of labor, capital, and operating capacity) and outcome quality performance.

### 3.3.3. Integrating Performance Frontiers and Competitive Capabilities

Where an organization falls on the performance frontier has been hypothesized to determine the applicability of trade-off versus competitive progression theoretical frameworks. Lapre and Scudder (2004) have hypothesized that a firms’ position along the frontier determines whether the trade-off or competitive progression theory holds.

Specifically, firms operating on or near their performance frontier are more likely to exhibit trade-offs among their competitive capabilities (Schmenner & Swink, 1998). This is thought to be more likely to occur because firms on or near their operating frontier are unable to make improvements along *multiple* improvement paths. They are forced to make choices, at least in the short term, as to which dimension of performance they wish to pursue. This limitation has been hypothesized to exist due to constraints placed on the firm by the set of assets (i.e., asset frontier) under command at the time of the performance enhancement choice (Hayes et al., 2004; Lapre & Scudder, 2004; Rosenzweig & Roth, 2004). To join the theories of performance frontiers and trade-off versus competitive progression, this research introduces a new frontier relationship, the integrative competitive frontier. The proposed “integrative capability frontier” is designed to depict the capability relationship between firms sitting on or near their performance frontiers and those residing somewhat distant from their frontiers. This integrative capability frontier is depicted in Figure 3.1.

Foundational and secondary are used within this study to denote a capability’s relative position per the sand cone competitive progression theoretical framework. Capabilities at lower levels of the sand cone model are “foundational” in relation to capabilities at higher levels (secondary) of the model. In this study, quality is deemed to be foundational while cost efficiency is secondary.

Firms (i.e., hospitals) residing on or near their performance frontiers reside within the “trade-off region” (1 and 2 from Figure 3.1). Firms within the trade-off region realizing gains in one capability (e.g., quality or cost efficiency) will of necessity see reductions, or trade-offs, in accompanying capabilities (e.g. cost efficiency or quality).

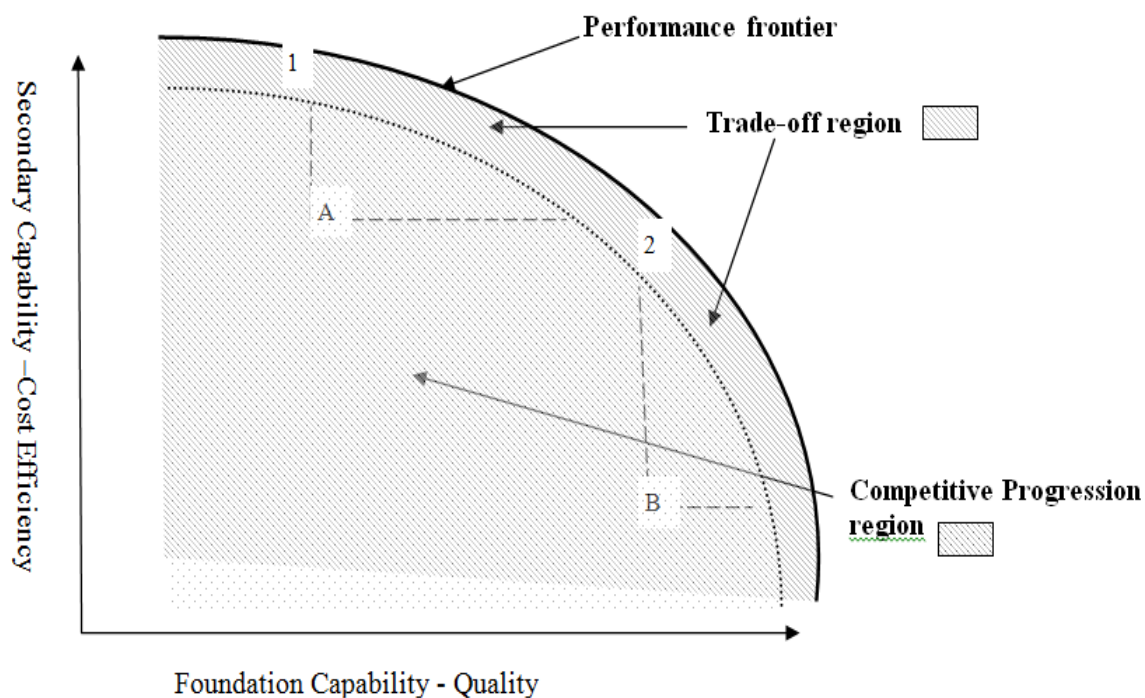


Figure 3.1: Integrative Capability Frontier Model

This relationship gives rise to:

**HYPOTHESIS 1.** *Firms residing at or near their performance frontier will exhibit a trade-off relationship between foundational and secondary competitive capabilities.*

Firms residing more distant from their performance frontiers (A and B from Figure 3.1) will exhibit a relationship between their competitive capabilities defined by the capability progression theoretical framework (Schmenner & Swink, 1998). As these firms move closer to their productivity frontier, they are capable of experiencing gains in both the foundational and secondary capability dimensions (area bounded by the dashed lines in Figure 3.1). Firms residing off their performance frontier and moving towards that frontier will exhibit gains in *both* foundational and secondary capabilities. Per CPT, gains in *both* foundational and secondary capabilities will accrue to firms distant from the

production frontier as they move towards that frontier. Foundational *and* secondary gains will be exhibited.

*HYPOTHESIS 2: Firms residing well off their performance frontier will exhibit a competitive progression relationship between foundational and secondary competitive capabilities as they develop these capabilities.*

An important distinction within the competitive progression framework relates to the relative magnitude of improvements to capabilities as firms approach their performance frontiers. Ferdows and DeMeyer (1990) prescribe specific, ordered capabilities and suggest the relative magnitude of improvements each of these capabilities will experience over time. The sand cone model of competitive progression has been proposed with the manufacturing sector in mind. This model is, in large part, a response to observed world-class manufacturing firm performance, wherein superior performance on *both* quality and cost efficiency was observed (Rosenzweig & Roth 2004). Quality is thought to precede other improvements (including cost efficiency) due to its being a “precondition to all lasting improvements” (Ferdows & DeMeyer, 1990). Lacking requisite quality, other improvements will not bring about desired gains in overall business performance. In a manufacturing setting, suboptimal levels of quality will result in either product rework or return. Either of these situations will, of necessity, result in reduced levels of product reliability, volume flexibility, and cost efficiency.

This model can be thought of as a more restrictive and manufacturing-centric subset of a larger competitive progression framework. So far as can be determined, the sand cone form of competitive progression has not been empirically supported within the service sector, the focus of this study. In a service setting, such as hospitals, quality is

also foundational. Reduced levels of quality will result in higher rework (readmissions) or failure (mortality) rates. These reductions in overall quality will of necessity, adversely impact down line, or secondary capabilities, including cost efficiency. Conversely, as hospitals experience gains in overall quality, enhancements in secondary capabilities will follow. This research then frames this prescriptive framework as the “sand cone form” of CPT and tests it within the hospital service sector. Per the sand cone model:

*HYPOTHESIS 2a: For firms residing well off their performance frontier, gains in foundational capabilities will be accompanied by gains of lesser magnitude in secondary capabilities (sand cone).*

Most of the research on CPT within the product manufacturing sector previously cited within this study has assumed some relative magnitude and order of capability progression. Prior research (Zeithaml, Parasuraman & Berry, 1990) has identified specific differences between service and product production and consumption processes. These differences rise primarily from the “inherent intangibility, inseparability of production and consumption, heterogeneity, and perishability that characterize services” (Nilsson, Johnson & Gustafsson, 2001). Due to the simultaneous processing and consumption of services, service organizations should feel compelled to develop capability improvements along multiple dimensions in a cumulative or simultaneous fashion. One way to frame this imperative is that service organizations do not have the luxury of focusing its improvement efforts on one domain and then another. Competitive pressures necessitate improvement along multiple trajectories, simultaneously.



A more generalized interpretation of CPT provides no specific prescriptive framework for the relative magnitude of capability progression, but suggests that capabilities generally accumulate over time (Flynn & Flynn, 2004; Stratman, 2007). Interpreted, this implies that the distinction between foundational and secondary capabilities is of less importance, but that they *both* have the imperative to show improvement. This more generalized competitive progression framework gives rise to what this study terms “parallel form” and is in line with the simultaneous production / consumption environment in which service organizations find themselves. Specifically regarding hospitals, they may not have the ability or luxury of first developing quality competencies and then secondary competencies such as cost efficiency. These organizations have the moral imperative to deliver high levels of quality, or customer service, while also showing improvements along the lines of cost efficiency (Giunipero, 1995).

*HYPOTHESIS 2b: For firms residing well off their performance frontier, gains in foundational capabilities will also result in simultaneous gains in secondary capabilities (parallel form).*

### 3.4. Data Sources and Measures

#### 3.4.1. Data Sources

Data for the study are derived from two secondary sources:

- The U.S. Department of Health and Human Services Hospital Compare Database (2005 – 2008) , (2006 – 2009) (HCD)
- The State of California Office of Statewide Planning and Development Annual Financial Data 2008, 2009 (OSHPD)

These data are separated into two separate panels. Panel 1 consists of HCD data from the 2005 – 2008 and OSHPD data from the 2008 timeframes. Panel 2 consists of HCD data from the 2006 - 2009 and OSHPD data from the 2009 timeframes.

#### 3.4.1.1. Hospital Compare Database (HCD)

The HCD provides hospital-provided and patient survey data on how well U.S. hospitals care for patients with a variety of medical conditions. These publically-available data set are updated quarterly and comprise data on a rolling annual basis. Hospitals voluntarily agree to submit patient-level data to the Department to Health and Human Services. The administrators of the data then aggregate the data from the patient level to hospital level, which is made publically available on the quarterly basis noted above. While the entire database is reposted quarterly, not all portions of the database are updated quarterly. Some portions of the database receive annual updates, within an appropriate quarterly update.

The database's purpose is two-fold. First, healthcare consumers can evaluate the availability and relative quality of care at hospitals they are considering for the provision of care via a series of predesigned queries. Second, the contents of the database are available for download and are intended for use by healthcare researchers and policymakers. This downloaded database from the timeframes noted above forms the basis of the data used within this study.

The downloaded HCD data, while consisting of over a dozen separate database files, primarily focuses on the following general measures; Process of Care, Outcome of

Care Outpatient Imaging Efficiency, and a Patients' Survey of Hospital Experiences.

This study utilizes data from the Process, Outcome, and Patients' Survey data.

#### 3.4.1.1.1 Process of Care Measures

The administrators of the HCD gather process of care measures on five (5) separate conditions: Heart Attack (Acute Myocardial Infarction or AMI), Heart Failure, Pneumonia, Surgical Care Improvement Project, and Children's Asthma Care. Process of Care data for only the first three conditions are utilized within this study. The reason for excluding the final two conditions is there being no equivalent reporting of Outcome of Care measures for these conditions. Each condition has four (4) to eight (8) separate recommended standard procedures which are recommended to be performed on patients exhibiting the given condition. The National Quality Forum (NQF) defines which procedures will be identified as standard procedures in treating individual conditions. The NQF is a separate, multistakeholder and independent organization which was created to "develop and implement a strategy for health care quality measurement and public reporting" (Department of Health and Human Services, Technical Appendix, n.d.). Process of Care measures are reported as the percentage of applicable cases exhibiting the given condition which received the given recommended procedure.

#### 3.4.1.1.2 Outcome of Care Measures

Outcome of Care measures consist of two separate individual outcome measures for each of the conditions Heart Attack (Acute Myocardial Infarction or AMI), Heart Failure and Pneumonia. These two outcome measures are 30-day risk-adjusted mortality and 30-day risk adjusted readmission. Each of these measures is rigorously risk-adjusted

to account for hospital-level and patient-level dissimilarities. An appendix provides a complete discussion of the statistical procedures utilized to achieve this risk-adjustment.

#### 3.4.1.1.3 Patients' Survey of Hospital Experiences

The survey of patients' hospital experiences (Hospital Consumer Assessment of Healthcare Providers and Systems - HCAHPS) is a standardized survey instrument administered by either individual hospital or approved third-party vendors to determine patients' satisfaction with specific in-hospital experiences. This survey can be administered via a number of modalities, consisting of 1) Mail only; 2) Telephone only; 3) Mixed (mail followed by telephone); and 4) Active Interactive Voice Response (IVR). Hospitals contact a random sample of patients to respond to this survey between 48 hours and 6 weeks after discharge. The survey contains 27 total but 18 "core" questions regarding patients' hospital experiences. (Department of Health and Human Services, Survey of Patients' Hospital Experiences (HCAHPS), n.d.).

The HCD is used to derive the following sets of Focus and Performance measures. *Performance Measures*: Safety (Outcome quality), Effectiveness, Patient Centeredness, and Patient Satisfaction. The individual HCD quarterly-updated data sets utilized within this study are used to construct two separate data panels. Panel 1 includes the years 2006-2007, and 2007-2008 for the July – June timeframe. Panel 2 includes the years 2006-2007, 2007-2008, and 2008 - 2009 for the July – June timeframe. Data for each panel were combined to a single HCD dataset to achieve consistency in reporting each of the measures described above. Mortality and readmission rates used in creating the Safety performance measure are reported for a 3-year (36-month) 2005-2008 timeframe. Panel 1 contains average, risk-adjusted mortality and readmission rates for

the 2005 – 2008 timeframe while Panel 2 contains average, risk-adjusted mortality and readmission rates for the 2006 – 2009 timeframe. To maintain consistency of data, other performance measures were combined to mirror the same panel timeframes as reported within the mortality / readmission data. Complete measures exist for 146 California hospitals.

#### 3.4.1.2. California Office of Statewide Planning and Development

##### Annual Financial Data (OSHPD) Database

The OSHPD is designed to provide public access to data on California healthcare facilities' infrastructure, outcomes, finances, safety, and capacity. These data are provided to allow residents, researchers, and policymakers access to data on which they can rely.

The OSHPD contains detailed production and financial data used in developing the efficiency measures used in this study. Measures used within this study include the number of discharges, the number of hospital full time equivalents, net property, plant and equivalents, and the number of beds and bassinets. Supplemental financial performance analysis utilizes net operating income. Panel 1 utilizes data for 2008 while panel 2 utilizes data for 2009. Data for a total of 146 California hospitals are utilized within this study.

#### 3.4.2. Measures

Measures used within this study are divided into two separate subgroups; 1) Measures of hospital outcome quality and, 2) Measures of hospital efficiency.

### 3.4.2.1. Measures of Hospital Outcome Quality

Measures of hospital outcome quality consist of aggregated, 30-day risk-adjusted mortality and readmission rates. This measure of healthcare quality is used within the healthcare and operations management literatures. Spertus et al. (2003) and Chung and Shauver (2010) use an outcome quality measures defined in terms of mortality / morbidity rates within a given facility. Outcome-based measures have been the focus of several studies. Chesteen et al. (2005) study the relationship between outcome quality and profit versus not-for-profit nursing homes.

Outcome quality scores for each hospital within HCD are reported and aggregated within this study. Thirty-day risk-standardized mortality and readmission rates for each condition at each hospital are summed to create an outcome quality score for each of the three conditions (heart attack, heart failure, and pneumonia) included in the study. This summed data for each of the three conditions is then averaged to create an overall outcome quality score for each hospital for the panel timeframe (Panel 1; 2005 – 2008, Panel 2; 2006 – 2009). While data are available for other conditions, these three conditions were specifically selected due to the prevalence of these conditions within the general population and the availability of corresponding process of care measures within the HCD dataset. This overall outcome quality score is then used as the measure of hospital outcome quality within the subsequent analysis. It should be noted that low to high mortality and readmission rates are equated with high to low outcome quality measures.

Risk-standardized mortality and readmission rates are often used as indicators when studying outcome quality. (Davies & Crombie, 1995; Krumholz et al., 2006;

Krumholz & Normand, 2008; Morley et al., 1992). This risk-standardized methodology overcomes a common critique of using outcome measures as a proxy for quality, namely that their interpretation is dependent upon the case mix and other hospital specific variables. Risk-standardized outcome measures specifically overcome this limitation and provide a robust proxy for hospital outcome quality.

A hierarchical regression model is utilized to compute hospital-specific 30-day readmission rates. (Note: This hierarchical regression is not part of this study. Data within the public dataset have already been subjected to this regression.) Specific patient-level factors considered in determining the risk-standardized mortality and readmission rates include gender, existing comorbidities, and past medical history. Specific hospital level factors utilized in determining the risk-standardized mortality and readmission rates include the unique quality of care for all patients treated for that condition in that hospital. The appendix contains more a more detailed description of the calculation of 30-day risk-standardized mortality and readmission rates.

Missing 30-day risk-adjusted mortality and readmission (i.e., not reported by hospital) scores are not included in the computation of the aggregate hospital outcome quality score.

#### 3.4.2.2. Measures of Hospital Efficiency

A two-stage stochastic frontier analytical (SFA) analysis is used to determine the measure of hospital efficiency. Production data from the OSHPD are utilized to create a log normalized Cobb-Douglas production function. The Cobb-Douglas production function requires:

- a measure of production output, and

- measure(s) of production input.

The output measure (Y) for this analysis is the total number of discharges from the hospital within the year. This discharge figure includes all hospital discharges including nursery discharges. Production function inputs are:

- productive capacity (C)
- labor (L)
- capital (K)

Productive capacity is derived by summing the total number of available beds and bassinets within a hospital. Labor is derived via the total number of hospital full-time equivalent employees for the year. Capital is derived via net property, plant, and equipment. Control variables in the production function include; type of ownership (government, for profit, not-for-profit), emergency service offered (Y/N), and number of operating rooms within the hospital (a proxy for hospital size). Assuming a log-linear Cobb-Douglas form, the stochastic production function takes the form of:

$$\ln Y_i = \ln C_i + \ln L_i + \ln K_i + V_i + U_i$$

where:

$Y_i$  = the expected production output frontier given production function inputs (C,L,K)

$V_i + U_i$  = the extent to which the hospital deviates from this frontier

$V_i$  = random error (noise) components

$U_i$  = systemic technical efficiency (Coelli et al., 2005).

The SFA technical efficiency component produces the measure for efficiency used within this study.



Data Envelopment Analysis (DEA) is an alternative methodology for examining production frontiers and technical efficiencies. SFA was used in this study because of its ability to separate and identify the random error and systemic technical efficiency components of the error within the production function (Greene, 2008; Kumbhakar & Lovell, 2000).

#### 3.4.2.3. Efficiency Independent Variables

The SFA used to estimate the efficiency of each hospital within this study utilizes the independent variables Process Standardization, Service Effectiveness, and Operational Focus. An overview of each of these independent variables is therefore included.

##### 3.4.2.3.1 Process Standardization

Process standardization measures provide process of care detail indicating “how often hospitals give recommended treatments known to get the best results for patients with certain medical conditions or surgical procedures. Information about these treatments are taken from the patients’ records and converted into a percentage.” (HCD Updated March 3, 2010) Process of care measures for three specific conditions are included within this study: heart attack, heart failure, and pneumonia. These measures are summarized in Table 3.1.

An aggregate process standardization score for each hospital is computed by averaging each of the process scores for each condition into a single hospital average. Missing process scores are not included in the computation of the aggregate process standardization score.

Table 3.1: Process Standardization Measure Summary

<b>Heart attack process of care best practice measures</b>	<b>Heart failure process of care best practice measures</b>	<b>Pneumonia process of care best practice measures</b>
Percent of Heart Attack Patients Given Aspirin at Arrival	Percent of Heart Failure Patients Given Discharge Instructions	Percent of Pneumonia Patients Assessed and Given Pneumococcal Vaccination
Percent of Heart Attack Patients Given Aspirin at Discharge	Percent of Heart Failure Patients Given an Evaluation of Left Ventricular Systolic (LVS) Function	Percent of Pneumonia Patients Whose Initial Emergency Room Blood Culture Was Performed Prior To The Administration Of The First Hospital Dose Of Antibiotics
Percent of Heart Attack Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)	Percent of Heart Failure Patients Given ACE Inhibitor or ARB for Left Ventricular Systolic Dysfunction (LVSD)	Percent of Pneumonia Patients Given Smoking Cessation Advice/Counseling
Percent of Heart Attack Patients Given Smoking Cessation Advice/Counseling	Percent of Heart Failure Patients Given Smoking Cessation Advice/Counseling.	Percent of Pneumonia Patients Given Initial Antibiotic(s) within 6 Hours After Arrival
Percent of Heart Attack Patients Given Beta Blocker at Discharge		Percent of Pneumonia Patients Given the Most Appropriate Initial Antibiotic(s)
		Percent of Pneumonia Patients Assessed and Given Influenza Vaccination

#### 3.4.2.3.2 Service Effectiveness

Service effectiveness is measured via a Survey of Patients' Hospital Experiences (HCAHPS) contained within the Hospital Compare Database. Eight items that encompass hospital cleanliness, communication with doctors and nurses, pain control, responsiveness of hospital staff, quietness, communication about medicines, and discharge information are contained within this survey. Patients report their experiences

on a 1-10 Likert scale, with 10 indicating the highest level. HCAHPS reports the number of patients reporting; 6 or lower, 7 or 8, and 9 and 10 for each item. An aggregate service effectiveness score, ranging from 0 to 1 is then computed for each hospital.

#### 3.4.2.3.3 Operational Focus

Healthcare facilities differ greatly in the breadth of services they offer. This breadth of service can be thought of closely paralleling the “focused factory” concept found throughout OM literature, with narrow service breadth paralleling higher degrees of factory focus (Bozarth & Edwards, 1997; Brush & Karnani, 1996; Ketokivi & Jokinen, 2006; Mukherjee et al., 2000; Pesch & Schroeder, 1996; Skinner, 1974). This study computes an Operational Focus (OF) score for each hospital and uses this variable as an indication of hospital focus. This OF score provides a measure of the degree to which an individual hospital focuses on specific procedures or provides a wide variety of procedural services. Individual procedures are coded through a “diagnosis related group” or DRG. Practically speaking, the OF ranges from 0 (a highly specialized facility) to under 10 (a facility offering a broad range of services), due to the limited number of DRGs specified by the Department of Health and Human Services.

Operational focus is ultimately a measure of the hospital’s degree of diversification of services. Varadarajan (1986) devised a methodology determining a measure of diversification. This methodology is modified within this study as the OF score and is operationalized as follows (Sorescu et al., 2003):

$$OF = \sum_{j=1}^n p_j \ln \left( \frac{1}{p_j} \right)$$

where:

$n$  = the number of discrete DRGs for which procedures were performed within the given year or reporting period.

$P_j$  = the number of procedures performed at the hospital in the  $j^{\text{th}}$  DRG.

$P$  = the number of procedures performed within the hospital over all DRGs

$p_j = P_j/P$ , the fraction of the hospital's procedures performed in the  $j^{\text{th}}$  DRG relative to all procedures performed by the hospital in all DRGs.

### 3.5. Analysis and Results

Cluster analysis has an established foothold within many of the business literatures. Miller and Roth (1994) and Frolich and Dixon (2001) utilize cluster analysis to create strategic groups (caretakers, marketers, innovators) based on clustering of 11 separate manufacturing capabilities. Software project risk has been conceptualized as fitting high, medium, and low classifications utilizing six dimensions of project risk (Wallace, Keil & Rai, 2004). Cluster analysis has also been utilized to evaluate a progression of manufacturing capabilities linkage to specific types of performance gains (Narasimhan, Swink & Kim, 2005).

New product development has been analyzed utilizing cluster analysis which shows trade-off properties among new product development performance outcomes more strongly in highly efficient projects than in more inefficient projects (Swink, Talluri & Pandejpong, 2006).

Menor et al. (2001) utilized cluster analytic techniques when evaluating the performance of banks relative to multiple operational competencies. In a similar fashion,

this study evaluates the operational competencies of outcome quality and cost efficiency relative to a hospital's position on a performance frontier.

### 3.5.1. Cluster Analysis

The first essay of this dissertation contains a supplemental appendix examining the relative contribution of hypothesized drivers of outcome quality and efficiency within performance quadrants segregated by high and low levels of both outcome quality and efficiency. Testing of hypotheses within this current study are facilitated using cluster analytical techniques. Cluster analysis affords this study the ability to empirically group hospitals based on specific performance criteria (i.e., quality and efficiency). The performance quadrant analysis of the first essay and the cluster analysis of this study differ in several fundamental aspects. These include:

- The supplemental quadrant analysis investigated the relative contribution of hypothesized drivers (process standardization, operational effectiveness, and hospital focus) to the dependent variables outcome quality and efficiency using cross-sectional data. This analysis' focus is on the relationship between inputs and outputs.
- The cluster analysis of this study investigates the relative movement of the dependent variables outcome quality and cost efficiency using two-period time-series data. This analysis' focus is on the movement of key outputs over time.
- The quadrant analysis provides insights regarding the relative profiles of drivers of quality and efficiency across several performance quadrants.

No additional theoretical insights are to be derived from this analysis over

and above that which was derived from the initial regression analysis performed within the first essay.

- The cluster analysis provides insights in examination of the trade-off and competitive progression theoretical frameworks. Specific findings from the cluster analysis can be used to support or refute these theoretical frameworks.

Once clusters have been created, properties of individual hospitals residing within individual clusters are evaluated for conformance to hypothesized trade-off versus competitive progression relationships using difference scoring and statistical significance testing.

Cluster analysis for the first data panel (05-08) is conducted utilizing the K-means method, utilizing Euclidian distance metric. Several cluster groups were analyzed and after evaluation of three-, four-, and five-cluster groupings. The four-cluster grouping was selected for several reasons:

- The K-means four-cluster grouping provides clusters based on two dimensions, quality and cost efficiency. The four cluster analysis naturally provides categorization of cluster groupings corresponding to high / low measures on each dimension.
- The centroids of four clusters reside naturally within the four quadrants of the high / low classification noted above.
- Two of the four cluster groupings lend themselves naturally to placement on and beneath the performance frontiers utilized in hypothesizing the

theoretical relationships between competitive capability trade-offs versus progression.

Centroids for each of the four cluster groupings are presented graphically and numerically in Figure 3.2 and Table 3.2. It should be noted that the measures for quality and cost efficiency have been standard normalized per recognized clustering methodologies so as to facilitate the Euclidean distance metric and to equally weight each of the clustering dimensions. For ease of visualization, the quality / cost efficiency measures were further standardized so as to move all measures within the upper right quadrant of Euclidean space. Hospitals residing within cluster 3 can be thought of as residing within that cluster which corresponds to relatively high levels of both quality and cost efficiency. Those facilities residing within cluster 1 are those whose cluster membership corresponds to relatively low levels of both quality and cost efficiency.

The four cluster grouping technique described above was used for subsequent analysis within this study.

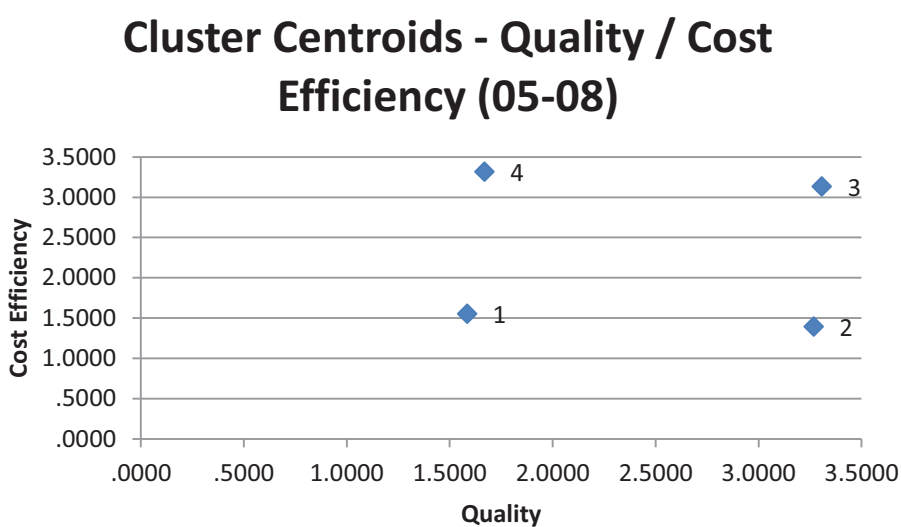


Figure 3.2: Cluster Centroids

Table 3.2: Cluster Descriptive Statistics

	05- 08 Performance Cluster				
<b>Competitive Capabilities</b>	<b>Cluster 1</b> Low Performance* ( <i>n</i> =25)	<b>Cluster 2</b> High Quality ( <i>n</i> =34)	<b>Cluster 3</b> High Performance** ( <i>n</i> =51)	<b>Cluster 4</b> High Efficiency ( <i>n</i> =36)	<i>F</i> = value <i>p</i> = probability
<b>Quality***</b>					
Cluster centroid	1.58	3.27	3.31	1.67	<i>F</i> = 97.61 <i>p</i> < 0.000
Std. error	0.09	0.09	0.09	0.10	
<b>Efficiency***</b>					
Cluster centroid	1.55	1.39	3.13	3.31	<i>F</i> = 140.50 <i>p</i> < 0.000
Std. error	0.11	0.09	0.07	0.08	

\* Resides well outside of theoretical performance frontier

\*\* On or near theoretical performance frontier

\*\*\* Full sample (*n* = 146) Normalized to *SD* = 1, Mean = 0 + min(Quality, Efficiency)

Each cluster mean / centroid differs significantly from others as evidenced by the one-way ANOVA *F*-statistic and associated probability. This provides support that the quality / efficiency performance characteristics within each cluster do exhibit significant differences.

### 3.5.2. Dependent Variable Measurement Invariance

For the analysis and follow-on conclusions envisioned by this research to be valid, the primary research measures must be consistent across measurement groups. In the case of this research, the groups consist of measuring the dependent variables outcome quality and efficiency across two separate timeframes. Assuring this measurement consistency across groups is referred to as measurement invariance or equivalence (Hult et al., 2008; Lai & Li, 2005; Malhotra & Sharma, 2008).

As a check that the quality / cost efficiency measures of panel 1 and 2 are appropriately equivalent in their make-up, Tables 3.3 and 3.4 compare the regression results of the dependent variables Quality (Table 3.3) and Efficiency (Table 3.4) for the



2005-08 (panel 1) and 2006 – 09 (panel 2) timeframes. Comparing parameter estimates of empirical modeling techniques is an accepted means of assuring measurement equivalence (Lai & Li, 2005).

Regarding outcome quality, Table 3.3 indicates that each independent variable coefficient is consistent in both its significance and sign across panel 1 and 2.

Table 3.3a repeats the same analysis, but reports using standardized coefficients.

Table 3.4 shows that the regression coefficients for the independent variables estimating efficiency are consistent across both panel 1 and 2. The levels of significance do vary somewhat across the two panels.

The first essay of this dissertation (Chapter 1) provides a detailed discussion of the regression and stochastic frontier analysis methodologies utilized constructing panel 1 and by extension panel 2 data. While differences between the coefficients for both dependent variables Quality and Efficiency exist between Panels 1 and 2, the general effect of the primary independent variable coefficients are consistent between both panels. Namely, the effects of Process Standardization, Service Effectiveness, and Operational Focus are all significant on Outcome Quality. Regarding Cost Efficiency, the production function Cobb-Douglas log-linear production function defined in Sec. 3.4.2.2, ( $\ln Y_i = \ln C_i + \ln L_i + \ln K_i + V_i + U_i$ ), supports the existence of a significant technical efficiency component and the independent variables which comprise the technical efficiency (i.e., cost efficiency) component are generally consistent. From these results showing consistency between the measures of Quality and Cost Efficiency between panels 1 and 2, the individual hypotheses concerning trade-off and/or competitive progression relationships within the clusters representing hospitals residing

Table 3.3: OLS Regression Results, DV = Outcome quality

	Panel 1 (2005- 08)	Panel 2 (2006 – 09)
<b>Independent Variables</b>		
Process Standardization	0.0169**	0.0294**
Service Effectiveness	0.0965**	0.0397**
Operational Focus	-0.0094**	-0.0072**
<b>Controls</b>		
Ownership - For Profit	0.0062**	0.0009
Ownership - Nonprofit	0.0042**	0.0031*
Emergency Service	-0.0021	-0.0054*
Accredited	0.0050	0.0045
<i>Adj. R-square</i>	0.1123	0.0907
<i>n</i>	1832	2324

\*, \*\*  $p < .05$  and  $.01$  respectively

Table 3.3a - OLS Standardized Beta Coefficient Regression Results, DV = Outcome quality

	Panel 1 (2005- 08)	Panel 2 (2006 – 09)
<b>Independent Variables</b>		
Process Standardization	0.0473**	0.0863**
Service Effectiveness	0.1936**	0.1483**
Operational Focus	0.2167**	0.1721**
<b>Controls</b>		
Ownership - For Profit	0.1196**	0.0201
Ownership - Nonprofit	0.1002**	0.0800*
Emergency Service	-0.0161	-0.0564*
Accredited	0.0375	0.0387
<i>Adj. R-square</i>	0.1123	0.0907
<i>n</i>	1832	2324

\*, \*\*  $p < .05$  and  $.01$  respectively

near and significantly distant from the performance frontier can now be evaluated.

### 3.5.3. Hypothesis Testing

The study now turns attention hypotheses evaluation. Difference scores for each hospital between panel 1 and panel 2 on each measure (outcome quality and cost efficiency) are computed. Of particular interest in evaluating these hypothesized relationships are hospitals residing within cluster 3 (on or near the performance frontier) and cluster 1 (maximum distance from performance frontier). These differences are then utilized to evaluate the presence of trade-off relationships in hospitals residing on or near

Table 3.4: SFA Results, Production Output =ln Discharges

	<b>Panel 1 (05-08)</b> First Stage <b>Production Function</b>	<b>Panel 1 (05-08)</b> Second Stage <b>Production Function and Technical Efficiency Function<sup>1</sup></b>	<b>Panel 2 (06-09)</b> First Stage <b>Production Function</b>	<b>Panel 2 (06-09)</b> Second Stage <b>Production Function and Technical Efficiency Function<sup>1</sup></b>
<b>Input Variables</b>				
Productive Capacity (ln (Beds+Bassinets))	.5898*	.4343*	.5733*	.4971*
Labor (ln FTE)	.3659*	.3735*	.4034*	.3600*
Capital (ln_PPE)	-.0140	.0054	-.0178	-.0217
<b>Technical Efficiency Variables<sup>1</sup></b>				
Process Standardization		1.118*		.9151
Service Effectiveness		-3.160*		-1.781
Operational Focus		-.3132*		-.2693*
Outcome quality		-4.799*		-4.148*
Ownership - Proprietary, for profit		.7367*		.6065*
Ownership - Nonprofit		.5482*		.3164
<b>Control Variables</b>				
Ownership – Proprietary, for profit	.1263*	.4373*	.1467*	.2240
Ownership - Nonprofit	.0672	.3989*	.0457	.1947
Emergency Service	-.1029	.0677	.0541	-.1774
Number of Operating Rooms	.0252	-.0106	.0031	-.0287
<b>Variance Parameters</b>				
Sigma – $v^2$	.8732	.0025	.0915	.0495
Sigma – $u^2$	.0246	.0709	.0208	.0066
<b>Test for technical efficiency</b>				
Ho: No technical efficiency component	$\chi^2 = 1052^*$		$\chi^2 = 1154^*$	
Log-likelihood function	11.85	27.08	24.76	39.81
Sample Size ( $n$ )	152	152	146	146

Truncated normal distribution, \* $p < .05$ , Similar results with half normal and exponential distributions

<sup>1</sup>SFA provides technical inefficiency coefficients. Results have been modified to reflect technical efficiency

the performance frontier (cluster 3) and competitive progression relationships in hospitals residing a maximum distance from the performance frontier (cluster 1).

Difference scores have been used in evaluating various aspects of healthcare quality and performance. Babakus and Mangold (1992) evaluated hospital service quality through difference scores by subtracting expectation scores from the corresponding perception scores on a SERVQUAL scale. Vandamme and Leunis (1993) utilized difference scoring to evaluate hospital service quality on a multi-item scale alternative to SERVQUAL. In evaluating clinical outcomes of a wide range of treatment protocols, difference scores in a healthcare context are used extensively (Hamilton & Abramson, 1983; Hoff et al., 2005; Ready et al., 2003).

Several studies within the business literature, particularly marketing, have also utilized various forms of difference scoring techniques (Alexander & Randolph, 1985; Donnelly, Hull & Will, 2000; Dougherty and Pritchard, 1985; Engelland, Workman & Singh, 2000).

Much of this prior research has focused on utilizing difference scores as predictors of an outcome (e.g., perceived quality). Edwards (1994) indicated that using difference scoring in this fashion assumes that the components of the difference score (e.g., actual performance and expectation of performance) have equal but opposite effects on the variable being predicted.

Page and Spreng (2002) illustrate this,

“... in the context of examining the effects of performance and expectations on perceived satisfaction.

$$\text{Satisfaction} = b_0 + b_1(D)$$

(1)

where  $D$  is the algebraic difference between performance and expectation ( $P_i - E_i$ ). Substituting this into Equation 1 and expanding yields

$$\text{Satisfaction} = b_0 + b_1(P_i - E_i)$$

(2)

$$\text{Satisfaction} = b_0 + b_1(P_i) - b_1(E_i).$$

(3)

This clearly assumes that the effect of performance on satisfaction ( $b_1$ ) must be equal and opposite to the effect of expectations ( $-b_1$ ). “Like any constraint, this *cannot* increase variance explained, and in most cases will decrease it. “This obviously calls into question studies attempting to demonstrate the superiority of algebraic difference indices over their components” (Edwards, 1994, p. 56).

The use of difference scores within this study does not attempt to provide any predictive results. Difference scores in this study are used simply to determine the time-series difference in magnitude of measures which have been either previously observed (quality) or empirically estimated (cost efficiency). The use of difference scores in a nonpredictive fashion avoids the deficiencies noted by previous authors.

Table 3.5 provides descriptive statistics and one-way ANOVA test of identical means of the quality and efficiency difference scores between panel 1 and panel 2 for each cluster.

Table 3.6 provides one-way ANOVA Scheffe test of difference of panel 1 and panel 2 means between each matched cluster.

The two clusters of primary interest are clusters 1 (well outside performance frontier) and 3 (on or near performance frontier). The Scheffe test summarized in Table 3.6 provides evidence that the Quality cluster mean differences are significant at the  $p < 0.10$  level from cluster 2, nearly significant at the  $p < 0.10$  level from cluster 3, and not different from cluster 4. Efficiency mean differences are significant at the  $p < 0.05$  level from all other clusters.

Table 3.7 provides a summary of the competitive progression / trade-off relationships for all 146 hospitals within panels 1 and 2. Hospitals exhibit one of the following relationships when evaluating difference scores:

- *Competitive Progression – Sand Cone Form:* The difference score between panel 1 and 2 for both outcome quality and cost efficiency is positive. Further in a test of the competitive progression sand cone theoretical framework, the foundational capability, quality, exceeds that of the secondary capability, efficiency.
- *Competitive Progression – Parallel Form:* The difference score between panel 1 and 2 for both outcome quality and cost efficiency is positive. This relationship is representative of the more general competitive progression

Table 3.5: Scheffe Cluster Difference Score Summary Statistics

Difference Score Mean	Cluster 1 Low Performance* (n=25)	Cluster 2 High Quality (n=34)	Cluster 3 High Performance** (n=51)	Cluster 4 High Efficiency (n=36)	F = value p = probability
Quality	0.0027	-0.0032	-0.0025	0.0042	F = 6.84 p < 0.05
Efficiency	0.1188	0.0719	0.0033	0.0045	F = 26.18 p < 0.05

\* Resides well outside of theoretical performance frontier

\*\* On or near theoretical performance frontier

Table 3.6: Scheffe Difference of Means Test Statistics

Difference Score Mean	Cluster 1* (n=25)	Cluster 2 (n=34)	Cluster 3** (n=51)
<b>Quality</b>			
Cluster 2	-0.0059/ 0.077		
Cluster 3**	<b>-0.0051/ 0.110</b>	0.0007 / 0 .983	
Cluster 4	0.0015 / 0 .923	0.0074 / 0.005	0.0067 / 0.006
<b>Efficiency</b>			
Cluster 2	-0.0469/ 0.046		
Cluster 3**	<b>-0.1155/ 0.000</b>	0.0686 / 0.000	
Cluster 4	-0.1142/ 0.000	-0.0674 / 0.000	0.0012 / 1.000

Cluster mean difference / p value

H<sub>0</sub>: mean difference not distinguishable from zero

\* Resides well outside of theoretical performance frontier

\*\* On or near theoretical performance frontier

Table 3.7: Competitive Progression / Trade-off Relationships

	All Facilities (n=146)	Cluster 1 Low Performance* (n=25)	Cluster 2 High Quality (n=34)	Cluster 3 High Performance** (n=51)	Cluster 4 High Efficiency (n=36)
% CPT – Sand Cone	3.42%	0.00%	2.94%	1.96%	8.33%
% CPT - Parallel	23.29%	<b>52.00%</b>	<b>23.53%</b>	5.88%	<b>27.78%</b>
% Trade-off	52.74%	<b>40.00%</b>	<b>64.71%</b>	<b>52.94%</b>	<b>50.00%</b>

\* Resides well outside of theoretical performance frontier

\*\* On or near theoretical performance frontier

framework wherein facilities exhibit cumulative improvements across multiple competitive capabilities.

- *Trade-off*: This relationship will exist as facilities exhibit one of the following:
  - An increase in quality between panels 1 and 2 (positive difference score), accompanied by a decrease in cost efficiency between panels 1 and 2 (negative difference score)
  - A decrease in quality between panels 1 and 2 (negative difference score), accompanied by an increase in cost efficiency between panels 1 and 2 (positive difference score)

For example, the “% CPT – Parallel / Cluster 1” cell from Table 3.7 is to be interpreted as 52% of the 25 facilities within Cluster 1 exhibit a parallel form of competitive progression. In analyzing clusters and defining their centroids, standard normalized data were used to avoid one measure exerting predominance over another. However, in evaluating the existence of competitive progression and / or trade-off relationships within each cluster, non-normalized data are used. This is done to evaluate the absolute magnitude of changes with respect to quality and cost efficiency within each cluster. The values in Table 3.7 are based on this non-normalized data.

Test statistics for two proportions are calculated to determine the significance of the capability relationships shown in Table 3.7. Table 3.8 provides a summary of these statistics. Two conditions should be met to support the CPT and trade-off theoretical frameworks within a given cluster.



1. A particular relationship (CPT and/or Trade-off) should exist in a large proportion within the cluster. The cluster / relationship pairs meeting this condition are bolded within Table 3.7.
2. The  $p$  value of that relationship should be significant within the cluster relative to the occurrence of that relationship within all other facilities of the sample.

Statistics for only that cluster / relationship combination meeting the first condition have been computed. A full interpretation of the results from Tables 3.7 and 3.8 is provided in Section 6 – Discussion.

#### 3.5.3.1. Off-performance Frontier (Cluster 1 – Competitive Progression)

##### Relationship

A competitive progression relationship is deemed to exist when *both* quality *and* efficiency exhibit a positive increase in their difference scores from panel 1 to panel 2. Per the first condition noted above, any cluster exhibiting relatively large proportion of CPT relationships are candidates for further testing to determine if this proportion is significant.

Per Hypothesis 2, hospitals residing well off the theoretical performance frontier (cluster 1) are expected to exhibit a competitive progression relationship between capabilities over the two time periods represented within panels 1 and 2. As seen within

Table 3.8: Competitive Progression / Trade-off Relationship Two Proportion Test Statistic

Cluster / Relationship	C1 / CPT-Parallel	C1 / Trade-off	C2 / CPT-Parallel	C2 / Trade-off	C3 / Trade-off	C4 / CPT - Parallel	C4 / Trade-off
<b>z Score</b>	-3.7310	1.4015	-0.0381	-1.5957	-0.0357	-0.7343	0.3793
<b>p value</b>	0.0001*	0.4192	0.4480	0.0559**	0.3632	0.2327	0.6480

\* $p < .05$ , \*\*  $p < .10$ ,  $H_0$ : Proportion Cluster Relationship = Proportion Sample Relationship

Table 3.7, 52% of cluster 1 facilities exhibit what this study calls the parallel form of competitive progression. This meets the first condition noted above. Further, from Table 3.8, the “Cluster 1 / CPT – Parallel” form relationship is significant at the  $p < 0.05$  level. This provides support for competitive progression within those facilities residing well off the performance frontier (i.e., Cluster 1 facilities).

From these results, this study finds support for Hypothesis 2 that competitive progression relationships exist within facilities residing well off the performance frontier. Little support is found for the more specific “sand cone” form of competitive progression of Hypothesis 2a in that no facilities within the first cluster exhibited this form of competitive progression. Significant support ( $p < 0.05$ ) for the more general “parallel” form of competitive progression is found and hence Hypothesis 2b is supported.

#### 3.5.3.2. On-performance Frontier (Cluster 3 – Trade-off) Relationship

Per the definition of relationships provided above, capability trade-offs will exist when *either* quality increases and efficiency decreases *or* quality decreases and efficiency increases. Any cluster with facilities exhibiting a large proportion of trade-off relationships are candidates for further examination, per condition 1 above.

Theoretically, cluster 3 represents those hospitals that should exhibit a competitive capability trade-off relationship due to their residing on or near the hypothesized performance frontier. If the tradeoff relationship formalized by Hypothesis 1 is to find support, both conditions 1 and 2 will be met. 52.94% of cluster 3 (See Table 3.7) hospitals exhibit a trade-off relationship, meeting condition 1. However this proportion is not significant per condition 2. Hypothesis 1, therefore, is not supported.

### 3.6. Discussion

The nature of the acquisition of competitive capabilities within the manufacturing sector has been the subject of Operations Management research over the past several decades (Ferdows & DeMeyer, 1990; Garvin, 1993; Hayes & Wheelwright, 1984; Hill, 1994; Mapes, et al., 1997; Narasimhan, Swink & Kim, 2005; Schonberger, 1990; Skinner, 1969, 1974; Szwejczewski, Mapes & New, 1997). Competitive capability research within the service industry has largely confirmed the trade-off versus competitive progression relationships theorized within the manufacturing sector (Menor et al., 2002; Stratman, 2007; Wang & Masini, 2010). This research sheds light on the two competing theories of competitive capability acquisition, trade-off and competitive progression, within the healthcare industry, a key component of the service sector (McLaughlin, Yang, & van Dierdonck, 1995). The conceptual model of Integrated Capability Frontiers was introduced to provide linkages between the trade-off and capability progression frameworks.

#### 3.6.1. Competitive Progression Theory – Parallel Form

For hospitals residing well off the hypothetical performance frontier, significant support was found for the presence of a progression among competitive capabilities. Referring to Table 3.7, facilities residing within cluster 1 are those exhibiting relatively initial low levels of both quality and cost efficiency, the two competitive capabilities measured within this study. It was found that 52% of facilities within cluster 1 ( $n=25$ ) exhibited the parallel form of competitive progression, meaning that both competitive capabilities quality and cost efficiency showed increases in their difference scores between panels 1 and 2. Further the null hypothesis of equivalence between the

proportions of facilities exhibiting competitive progression is rejected, supporting Hypothesis 2b or the Parallel Form of Competitive Progression. This finding supports prior theory that facilities which are distant from their performance frontier are capable of simultaneous improvement along multiple competitive dimensions. This improvement is facilitated due to the fact that these facilities can avail themselves of capital and human assets which are not being utilized to their full capacity.

Managerially speaking, this finding suggests that hospitals residing well off their performance frontiers can develop strategies and programs focused on simultaneous improvement along both the quality and cost efficiency dimension. Administrators should be able to obtain a general idea as to where they rate in relation to other hospitals relative to these capabilities. The popular press (i.e., U.S. News and World Report - Best Hospitals 2011-12: the Honor Roll) and government data sources such as the U.S. Department of Health and Human Services' Hospital Compare Database can readily provide an indication of where hospitals rank relative to other hospitals on quality measures. Facilities residing distant from a performance frontier (i.e., low quality rankings relative to other hospitals) should focus their efforts on gaining improvements on multiple capabilities. Administrators and/or clinical directors in these environments should not feel constrained to initiating improvements along a single improvement path. Specific improvement initiatives can be articulated in terms of how they will beneficially impact *both* outcome quality and efficiency. By improving on multiple capability dimensions, rapid relative improvement is possible.

### 3.6.2. Competitive Capability Trade-off

Limited support for the capability trade-off theory was found for those facilities residing on or near their performance frontier. Again referring to Table 3.7, hospitals residing within cluster 3 ( $n=51$ ) are those exhibiting relatively higher initial levels of both quality and cost efficiency, the two competitive capabilities measured within this study. 52.94% of facilities within cluster 3 exhibited trade-offs between competitive capabilities, meaning that quality and cost efficiency showed an increase / decrease *or* decrease / increase in their difference scores between panels 1 and 2. However, this proportion is not significantly different from the proportion exhibited by other facilities within the sample. This finding does not strongly refute the Capability Trade-off theoretical framework and provides limited support for Hypothesis 1 of this study.

Administrators and clinical directors of this type of facility should structure improvement efforts dedicated to a particular capability (i.e., outcome quality *or* efficiency). Recognizing that they might be limited by their current capital or human asset base (Lapre & Scudder, 2004), improvement efforts should be directed towards a specific capability (i.e., outcome quality) without detrimentally impacting competing capabilities (i.e., cost efficiency). The focus in this environment should be one of incremental improvement. Again, using the popular press and government resources, administrators can gain a general indication as to their relative standing to assist them in targeting specific capabilities on which to focus improvement efforts.

### 3.7. Conclusions and Limitations

From the data and analyses of this research, strong support is provided that hospitals residing well off their performance frontier exhibit competitive progressive

capabilities and are capable of advancing along both quality and efficiency capability dimensions. Limited support is provided that facilities sitting on or near their performance frontier exhibit trade-off relationships between their quality and cost efficiency capabilities. This research utilizes data from 146 hospitals across two timeframes. A key limitation of this research is that data from only two timeframes or panels is utilized. As additional data are released by the suppliers of data for this study, more rigor using time-series analysis techniques can be used to model and test the hypotheses.

From prior essays within this dissertation, it is apparent that distinct differences exist when evaluating outcome quality and efficiency within hospitals under different ownership structures. These differences in ownership can be evaluated when conducting follow-on longitudinal research. The data from this study also suggest that hospitals which exhibited a relatively high degree of outcome quality in panel 1 (2005-08) experienced a reduction in outcome quality in panel 2 (2006-09). This decrease in quality by previously high performers should be examined. Has the recent economic downturn had a detrimental effect on outcome quality? To what degree does the current regulatory environment affect outcome quality? Are there unintended consequences associated with additional healthcare regulations?

Hospital and healthcare quality and efficiency will continue to play an increasing role in economic and policy debates. Furthering research of the types contained within this essay will continue to be of value, particularly within operations management.

### 3.8. Appendix – Risk-adjusted Mortality and Readmission

Quoted directly from:

U.S. Department of Health and Human Services, Hospital Compare Database website (<http://www.hospitalcompare.hhs.gov/staticpages/for-professionals/ooc/statistical-methods.aspx>)

#### Statistical Methods Used to Calculate Rates - Mortality Measures

##### Hierarchical Regression Model

The statistical model for computing 30-day risk-adjusted mortality rate measures is a "hierarchical regression model." This type of model is based on the assumption that any heart attack or heart failure or pneumonia patients treated at a particular hospital will experience a level of quality of care that applies to all patients treated for the same condition in that hospital. In other words, the expected risk of death for two similar heart attack or heart failure or pneumonia patients treated in the same hospital would be more alike than the risk of death for the same two patients treated in two different hospitals. The likelihood that an individual patient will die is therefore a combination of:

- his or her individual risk characteristics (for example, gender, comorbidities, and past medical history) and
- the hospital's unique quality of care for all patients treated for that condition in that hospital.

The model estimates the effects of both of these components on mortality.

##### Calculating Mortality Rates

Each hospital's "30-day risk-adjusted mortality rate" (also called the "Risk Standardized Mortality Rate" or RSMR) is computed in several steps. First, the *predicted* 30-day mortality for a particular hospital obtained from the hierarchical regression model is divided by the *expected* mortality for that hospital, which is also obtained from the regression model. Predicted mortality is the rate of deaths from heart attack or heart failure or pneumonia that would be anticipated in the particular hospital during the 12-month period, given the patient case mix and the hospital's unique quality of care effect on mortality. Expected mortality is the rate of deaths from heart attack or heart failure or pneumonia that would be expected if the same patients with the same characteristics had instead been treated at an "average" hospital, given the "average" hospital's quality of care effect on mortality for patients with that condition. This ratio is then multiplied by the national unadjusted mortality rate for the condition for all hospitals to compute a "risk-adjusted mortality rate" for the hospital. So, the higher a hospital's predicted 30-day mortality rate, relative to expected mortality for the hospital's particular case mix of patients, the higher its adjusted mortality rate will be. Hospitals with better quality will have lower rates.

(Predicted 30-day mortality/Expected mortality) \* U.S. National mortality rate = RSMR

## Statistical Methods Used to Calculate Rates - Readmission Measures

### Hierarchical Regression Model

The statistical model for computing the 30-day risk-standardized readmission rates is a "hierarchical regression model." This type of model is based on the assumption that any heart attack, heart failure, or pneumonia patient treated at a particular hospital will experience a level of quality of care that applies to all patients treated for the same condition in that hospital. In other words, the expected risk of readmission for two similar heart attack, heart failure, or pneumonia patients treated in the same hospital would be more alike than the risk of readmission for the same two patients treated in two different hospitals. The likelihood that an individual patient will be readmitted is therefore a combination of:

- his or her individual risk characteristics (for example, gender, comorbidities, and past medical history) and
- the hospital's unique quality of care for all patients treated for that condition in that hospital.

The model estimates the effects of both of these components on on risk of readmission.

### Calculating Readmission Rates

Each hospital's 30-day risk-standardized readmission rate (RSRR) is computed in several steps. First, the predicted 30-day readmission for a particular hospital obtained from the hierarchical regression model is divided by the expected readmission for that hospital, which is also obtained from the regression model. Predicted readmission is the number of readmissions (following discharge for heart attack, heart failure, or pneumonia) that would be anticipated in the particular hospital during the study period, given the patient case mix and the hospital's unique quality of care effect on readmission. Expected readmission is the number of readmissions (following discharge for heart attack, heart failure, or pneumonia) that would be expected if the same patients with the same characteristics had instead been treated at an "average" hospital, given the "average" hospital's quality of care effect on readmission for patients with that condition. This ratio is then multiplied by the national unadjusted readmission rate for the condition for all hospitals to compute an RSRR for the hospital. So, the higher a hospital's predicted 30-day readmission rate, relative to expected readmission for the hospital's particular case mix of patients, the higher its adjusted readmission rate will be. Hospitals with better quality will have lower rates.

$(\text{Predicted 30-day readmission} / \text{Expected readmission}) * \text{U.S. National readmission rate} = \text{RSRR}$



### 3.9. References

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