Testing the hospital value proposition: An empirical analysis of efficiency and quality

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Abstract:

Purposes: To assess the relationship between hospitals' X-inefficiency levels and overall care quality based on the National Quality Forum's 30 safe practices score and to improve the analytic strategy for assessing X-inefficiency.

Methodology: The 2005 versions of the American Hospital Association and Leapfrog Group's annual surveys were the basis of the study. Additional case mix indices and market variables were drawn from the Centers for Medicare and Medicaid Services data sources and the Area Resource File. Data envelopment analysis was used to determine hospitals' X-inefficiency scores relative to their market-level competitors. Regression was used to assess the relationship between X-inefficiency and quality, controlling for organizational and market characteristics. Expenses (total and labor expenditures), case-mix-adjusted admissions, length of stay, and licensed beds defined the X-inefficiency function. The overall National Quality Forum's safe practice score, health maintenance organization penetration, market share, and teaching status served as independent control variables in the regression.

Findings: The National Quality Forum's safe practice scores are significantly and positively correlated to hospital X-inefficiency levels ($\beta = .105$, $p \leq .05$). The analysis of the value proposition had very good explanatory power (adjusted $R^2 = .414$; $p \leq .001$; df = 7,265). Contrary to earlier findings, health maintenance organization penetration and being a teaching hospital were positively related to X-inefficiency. Similar with others' findings, greater market share and for-profit ownership were negatively associated with X-inefficiency.

Practice Implications: Measurement of overall hospital quality is improving but can still be made better. Nevertheless, the National Quality Forum's measure is significantly related to efficiency and could be used to create differential pay-for-performance programs. A market-segmented analytic strategy for studying hospital's efficiency yields results with a high degree of explanatory power.

Key words: hospitals, organizational efficiency, quality

Article:

The quality and efficiency of the U.S. health care system are not what it should be. Hospitals, in particular, have been criticized as having inconsistent quality control processes that have led to increased lengths of stay, additional charges due to preventable errors, and excess mortality (Zhan & Miller, 2003). In other words, poor quality of care creates system-wide inefficiencies. Further, these inefficiencies are contributing to the above-average health care inflation that is endemic in the U.S. system when compared with that in other industrialized nations. Therefore, striving for better quality of care processes within hospitals should be systematically and positively related to greater efficiency gains within facilities.

Despite the intuitive appeal that better quality and increased efficiency should move together, it has been difficult to empirically demonstrate the "value proposition" at the institutional level in health

care. Large-scale systematic efforts that comparatively assess hospitals' overall quality are in their early stages. The National Quality Forum (NQF) and the Hospital Quality Alliance both sponsor programs to assess hospitals' performance that were initiated in 2003 (Morrissey, 2003; Ward, Evans, Spies, Roberts, & Wakefield, 2006) and 2004 (Jha, Li, Orav, & Epstein, 2005), respectively. Hospital cost efficiency, on the other hand, has been extensively studied, as have the organizational and market factors that influence performance (e.g., Carey, 2003; Chirikos, 1999; McKay, Deily, & Dorner, 2003; Rosko, 2004). Researchers have begun to look at the quality–cost relationship (e.g., Jiang, Friedman, & Begun, 2006); however, there have been no large-scale studies using the newly developed hospital metrics that examine the value proposition that quality and efficiency are positively related.

The purpose of this study is to test the hospitals' value proposition. In particular, the relationship between the hospitals' relative X-inefficiency within their markets and its relationship to quality using the NQF's safe practices standards are explored. A two-stage approach was used in the analysis (Rosko & Chilingerian, 1999). In the first stage, a data envelopment analysis (DEA) to determine the cost function was estimated for 273 hospitals in the 19 largest consolidated metropolitan statistical areas (CMSAs). Unlike earlier studies (e.g., Carey, 2003; Rosko, 2001a, 2004), the DEA was performed on a market-by-market basis (i.e., 19 separate DEAs were run) rather than by combining the entire sample and then controlling market characteristics. In the second stage, the estimated inefficiency scores were used as dependent variables to assess their relationship with the NQF's safe practices scores, organizational characteristics (e.g., system type, teaching programs, and ownership), and external market pressures (e.g., health maintenance organization [HMO] penetration and hospital market share).

Establishing the relationship between hospital efficiency and quality metrics is of critical interest to health services researchers, purchasers, and policy-makers seeking to improve the U.S. health care system's effectiveness while simultaneously controlling costs— collectively increasing value. The Centers for Medicare and Medicaid Services' (CMS') policy goals were recently highlighted by the Secretary of Health, Michael Leavitt, who stressed the importance of a value-driven reform plan, which provides better quality at lower cost (Manos, 2008). Although improving either quality or cost independently may increase the overall value, the current belief among many purchasers, including the federal government, is that inefficiency is the result of poor quality. In the same speech, Secretary Leavitt emphasized the need for standardized quality metrics that are available to consumers.

Assessing one of the recently developed quality metric's statistical powers with a large-scale sample of hospitals is an important step in improving measurement science. In addition, the hierarchical market-level approach to DEA increases the congruence between research methods and the standard economic theory on the function of markets. Further, DEA creates a more parsimonious analysis by reducing the need for market-level control variables. From the perspective of both purchasers and policymakers' perspectives, the analysis explores the reliability of the hospital quality and cost information that some pay-for-performance programs are using as basis for designing health benefit plans.

The article begins with a brief review of the hospital quality assessment movement. Next, the sample description and analytic strategies are described followed by the results. A discussion of the major findings is offered. Lastly, the conclusions, limitations, and areas of future research are provided.

Conceptual Framework

The hospital value proposition is predicated on the belief that poor care quality leads to higher costs because patients require additional treatment to address failures in the delivery of the standard of care or, in the worst case, remediate medical errors that have caused additional harm. In other words, poor quality of care leads to less efficient use of health care resources. The increasing health care

expenditures in the United States, coupled with quality concerns, have stimulated several contemporary trends focused on the value proposition (Clancy, 2004). Most of the nationwide efforts have increased the amount, validity, and availability of the clinical process and outcome information as key starting points for their improvement programs (Marshall, Shekelle, Leatherman, & Brook, 2000). The underlying belief is that more information will prompt consumers and purchasers to shift their consumption patterns to better rated providers and facilities (Ford & Scanlon, 2007).

With respect to hospitals, there are two major quality information initiatives. The two initiatives are closely linked, and there are ongoing efforts to harmonize these measures. One is the Hospital Quality Alliance's initiative launched in 2003 by a consortium of organizations, including CMS, the Joint Commission on Accreditation of Healthcare Organizations, and the American Hospital Association (AHA; Jha et al., 2005). The other, and the focus of this study, is the NQF's Safe Practices for Better Healthcare: A Consensus Report (Road-map for safety: National Quality Forum officially releases 30 safe practices for better healthcare, 2003).

The NQF's safe practices have been incorporated into the Leapfrog Group's annual survey of hospitals. Leapfrog's goal is to "encourage health providers to publicly report their clinical care processes so that consumers and purchasing organizations can make informed health care choices" (Leapfrog Group home-page, 2007). Therefore, the measures are being collected using a nationwide survey targeting the most active health care markets. However, quality is only half of the value proposition.

Value is inherently a relative assessment of one organization's quality and efficiency compared with other choices in the market place. Therefore, some component of the value function must reside at the market level. Local labor and supply costs in particular tend to be market driven. The movement to improve the health care system has determined that quality should be assessed using comparable metrics so facilities can be compared on a national basis. The underlying logic is that there are evidence-based standards of care regardless of where services are delivered—hence national standards.

Efficiency, on the other hand, has a significant local component determined by prevailing market conditions, such as wages, insurance contracting (HMO penetration), and competition. Because different regions of the country have significantly different market input prices for labor and supplies, the Medicare program adjusts the prices it pays providers to reflect what "efficient providers would incur for furnishing high quality care" (Adjusting Medicare payments for local market input prices: Statement before the U.S. House of Representatives, 2002). However, quality and input costs are not the only factors that impact an organization's potential efficiency vis-á-vis other hospitals in the market.

Both organizational features and market structures will impact what determines optimal efficiency. At the institutional level, characteristics such as ownership structure (e.g., community, nonprofit, or for profit), market share, and the presence of residency or other educational programs will effect how hospitals pursue their mission. At the market level, greater competition and the level of HMO activity have both been found to increase efficiency (Rosko & Chilingerian, 1999; Rosko & Mutter, 2008). Further, different regions have different levels of medical education. To the extent that medical education programs provide a subsidized source of labor, they too will influence a region's efficiency compared with other parts of the country.

The measurement of hospital X-inefficiency has a longer history than that of the health care quality movement. However, there is still debate about the best analytic strategy to employ in calculating the X-inefficiency measure (Newhouse, 1994). Both DEA and stochastic methodologies have been widely used, but there is clearly room for methodological improvements and innovations that allow

researchers to select from a range of analytic strategies to find the one best suited to their questions and data (Rosko & Mutter, 2008).

Methods

This article extends the methodologies of earlier studies of system hospital performance by evaluating hospitals' "technical" efficiency using DEA at the market level. Typical analyses of cost data (Coverdale, Gibbs, & Nurse, 1980; Poverejan, Gardiner, Bradley, Holmes-Rovner, & Rovner, 2003; Regier, Sunderji, Lynd, Gin, & Marra, 2006) often build cost functions using regression analysis, which seeks to identify a line of best fit for a data set. Rather than identifying the line which best represents the relationship between two variables, DEA is a data-intensive analytic method, which seeks to identify the "leading edge" on which the most efficient organizations balance both input and outputs.

Data envelopment analysis is one of a number of nonparametric methods used to measure the relative technical efficiency of a homogenous number of organizations that essentially perform the same tasks (Sanhueza, Rudnick, & Lagunas, 2004). Within that context, organizations that reside off the cost frontier may suffer from excess input allocations (technical inefficiency) or from incorrect combinations of inputs (allocative inefficiency). It is necessary to have input cost data to accurately assess "allocative" efficiency; input costs are determined at the market level. Therefore, a different market's prevailing input costs will lead to different optimal allocation strategies in each market. By analyzing technical efficiency at the market level, one of the factors that determine allocative efficiency, market pricing of inputs, is controlled for—albeit indirectly.

This research specifically extends the efforts made by Carey (2003) to study similar factors in similar contexts. In that work, Carey draws on stochastic frontier analysis (SFA) rather than on DEA to identify the efficiency frontier. The argument for SFA as a frontier model is compelling—"DEA has a critical shortcoming in that it ignores the possibility that the observations in the data may be subject to random fluctuations" (Carey, 2003, p. 29). SFA is an extension of regression analysis made under the assumption that the residual from the simple regression approach can be decomposed into two factors—statistical error and inefficiency. Inefficiency is assumed to be a nonnegative value and follow a particular statistical distribution (e.g., half-normal) based on the assumption that an organization of business unit demonstrating zero inefficiency resides on the cost frontier. SFA can be used to assess allocative efficiency if input price data are available. DEA, in contrast, does not require input price data; however, it assumes no measurement error. Therefore, DEA is limited to the estimation of technical efficiency using inputs that are not priced, whereas SFA can be used to assess allocative efficiency. Both are necessary to measure cost inefficiency.

Knowing the prevailing price of an input is critical to understanding allocative efficiency because managers will seek to substitute high cost inputs with complementary inputs of a lower price to optimize allocative efficiency. Because prices are determined in the local market, in the absence of such information, it is difficult to compare organizations from different markets. Our approach here was to use a market-segmented DEA, which allows the identification of technical efficiency frontiers within markets and results in both a more context-specific application of DEA and the calculation of slack resources in each market. We believe that this is a more appropriate analytical approach, in part, because it inherently controls for the input costs common to facilities in the same market. Said differently, although a hospital in Newark may be underutilized, it ought to not simply accept the overutilization of hospitals in Miami as a standard determination of overall efficiency. Arguably, then, it would seem more appropriate and locally relevant for determinations of any type of efficiency to take place within local contexts rather than against global ones. Using DEA, we identify the data frontier technical inefficiency (X-inefficiency) function:

$C = f(w,X)$

as subject to both input and outputs, where C is the total cost, w is the input price, and X is a vector of outputs and other factors that affect cost. Our DEA was conducted using DEAP 2.1, a program published by The Centre for Efficiency and Productivity Analysis. Subsequent analysis was conducted using SPSS 15.0.

We drew on four data sets for our analyses. The first data set was the fiscal year 2005 edition of the AHA's annual survey. Those data were augmented with the Leapfrog Group's annual survey from the same year. The Leapfrog data contained the NQF's safe practices metric. The Area Resource File provided the Medicare HMO penetration rate and the CMSA variables for 2005. The case mix index (CMI) for 2005 was drawn from publicly available files. All of the data sets used the AHA's identification number for merging the files.

We began our analysis by drawing on Carey's (2003) input–output model for defining the components of efficiency when drawing on the AHA data set. In Carey's article, the average annual salary and number of beds for each hospital were used as inputs, and the adjusted admissions and adjusted patient days were used as outputs. The Medicare diagnosis-related group inpatient CMI was used to adjust the admissions to control for differences in acuity across facilities.

We took a slightly different approach in that we submit that CMI is, in fact, an input variable by viewing hospitals as organizations that take patients with various health problems and process them through the health care system. This perspective would then necessitate that the complexity of the cases coming to the organization is an input rather than an output. Further, because we used a market-level approach, we no longer needed to make wage adjustments to account for local factors because our analysis was inherently local. As a result, we define the inputs of hospitals by the money invested in the people and facilities (total facility expenditures), the number of beds available at the facility (a measure of capacity), and a metric reflecting the clinical complexity of the patient population admitted—measured using the CMI. In terms of outputs, we argue that adjusted patient days (adjusted patient days of care take into account the outpatient care provided by the hospital because staffing level data do not distinguish between inpatient and outpatient staffing) and number of admissions are appropriate output measures. Both measures are indicative of organizational throughput. The former establishes a metric related to revenue for the organization, whereas the latter measures not only input but also output under the expectation that individuals admitted are discharged as well.

Taking a market-level analysis as the first step is in sharp contrast with previous studies (cf. Chirikos, 1999; McKay et al., 2003; Rosko & Chilingerian, 1999; Zuckerman, Hadley, & Iezzoni, 1994). In the calculation of the market-level efficiency, every hospital that provided complete input and output variables to the AHA was included, rather than reducing the data set to the Leapfrog respondents. In doing so, a more robust estimate of the relative market efficiency of each hospital can be ascertained prior to doing the second step of the analysis. Nineteen markets were used. Markets ranged in size from having 19 (Sacramento) to 241 (New York) hospitals, with a mean number of 47.3 hospitals per market. Altogether, 899 facilities were included in the initial DEA used to create the X-inefficiency measure.

For the second stage of the analysis, it was necessary for the hospital to have responded to the Leapfrog Group's annual survey to have a NQF's safe practices score. Altogether, 273 hospitals in the 19 targeted markets responded to the survey, provided information on every other variable of interest, and were used in the regression analysis. The safe practices composite score measure was skewed toward reported full compliance. Therefore, the variable was recoded into quintiles, with the value 1 being the lowest attaining group of hospitals and 5 being the highest classification.

Several additional structural variables were drawn from the AHA data set. A for-profit ownership control dummy variable is included to explore the public– private structures' impact on efficiency. Finally, we have followed past practice by including membership in the Council of Teaching Hospitals of the Association of American Medical Colleges (COTH). Data were also gathered on environmental variables included in the model. Market share was calculated from AHA data based on the percentage of total admissions within a geographic domain—often CMSAs, but where a hospital was not within a CMSA, markets were defined by county. Medicare HMO penetration rate was taken from the Area Resource File data set. The Herfindahl measure was calculated using admission counts from the AHA data set. Summing the number of COTH facilities in a market and dividing it by the total number facilities was used to calculate the amount of medical education in the market.

Findings

Analysis on the dependent variable X-inefficiency (technical efficiency) was determined through regression along the seven independent variables (four institutional level and three market level). For all but two independent variable, the relationships were determined to be significant at p > .01. The NQF's safe practice score was significant at p :5 .05, and the COTH–market variable was not significant at the levels typically used by health services researchers. The means and correlations for all variables are displayed in Table 1.

With the exception of market share and ownership control code, the independent variables were positively correlated to the dependent variable (see Table 2). In the case of market share, the results are open to two possible interpretations. One explanation is that diseconomies of scale are making facilities less technically efficient. A second explanation is that as competition within a market decreases and organizations hold a greater amount of market share, efficiency suffers. The two options are not mutually exclusive, and both factors may play a role. The market-level measure of competition's positive coefficients (Herfindahl) supports the contention that markets with multiple competitors result in greater efficiency across the market as a whole. We also note that governance for each hospital affects efficiency. The analysis indicates that being a for-profit institution has a significant and negative impact on efficiency, supporting the contention that publicly run and nonprofit hospitals are, on average, more efficient than privately run hospitals. This finding runs counter to common perception that private production of services results in a generally more efficient than nonprofit production.

Table 1

Variable means and correlations

	M	*SD*							
Organizational X-inefficiency[a]	0.451	0.267							
NQF's overall safe practices score in quintiles	3.00	1.424	.108**						
For-profit dummy code	2.01	0.690	−.059**	−.020					
Market share within the CMSA	0.189	0.253	−.457**	.004	−.204**				
Member of the COTH	0.060	0.235	.187**	.020	−.062**	−.034*			
Herfindahl index	0.400	0.402	−.324**	−.082*	−.311**	.888**	−.125**		
HMO penetration rate	0.215	0.176	.420**	.136**	.197**	−.429**	.201**	−.538**	
Percentage of COTH in CMSA	0.120	0.068	.147**	.132	−.127**	.001	.211**	−.013	.005

Note. NQF = National Quality Forum; CMSA = consolidated metropolitan statistical area; COTH = Council of Teaching Hospitals of the Association of American Medical Colleges; HMO = health maintenance organization.

[a]Organizational X-inefficiency was calculated relative to other facilities in their CMSA.

*$p < .01$; **$p < .001$.

Table 2

Regression results[a]

Independent variables	Organizational-level controls—Model 1		Market-level controls—Model 2	
	Standardized coefficients	Significance	Standardized coefficients	Significance
NQF's safe practices score in quintiles	.100	.050	.105	.030
For-profit dummy code	−.244	.000	−.148	.004
Market share within the CMSA	−.508	.000	−.957	.000
Member of the COTH	.142	.006	.139	.005
Herfindahl index			.701	.000
HMO penetration rate			.354	.000
Percentage of COTH facilities in CMSA			.069	.172
df	4, 268		7, 265	
F	29.478		26.975	
F-change			19.044	.000
R^2 (adjusted R^2)	.270 (.295)		.416 (.414)	

Note. NQF = National Quality Forum; CMSA = consolidated metropolitan statistical area; COTH = Council of Teaching Hospitals of the Association of American Medical Colleges; HMO = health maintenance organization.

[a]Dependent variable: CMSA market efficiency measure scored that a positive coefficient in the independent variables is associated with

Facilities that served as teaching hospitals (member of the COTH) were systematically more efficient than their counterparts without such programs. The presence of medical residents may represent a relatively low-cost complement for other types of clinicians and a concomitant increase in efficiency. The market-level assessment of the presence of teaching hospitals was not significantly related to the technical efficiency variable. Taking the two variables' results together, it does not appear that having a large medical education sector in a market is systematically related to increased efficiency.

The overall model was robust (adjusted R = .414), and overall model was found to be significant at $p < .001$. Because the most conservative of all possible observation inclusion strategies was used, the total observed values for which all required full data resulted in a reduction in the number of cases to 273 (applying a "list-wise deletion" criterion). As noted earlier, the efficiency was calculated on a much larger set, resulting in a more robust calculation of the dependent variable (viz, X-inefficiency).

Discussion

The two major aims of this study were to assess the value proposition that better quality is systematically related to greater efficiency and that using a market-level analytic methodology was an effective strategy. Both aims were achieved with positive results. Further, the additional control variables' significance levels and relational direction provide valuable insights into both the safe practice measure's utility and the analytic approaches' performance. Each aim and the implications of the control variables' performance are discussed in turn.

National Quality Forum's Safe Practices Measure and Hospital Efficiency

Purchasers and policymakers have placed a great deal of emphasis on the link between quality and efficiency. Further, both groups have asserted that the health care payment system as it is currently

structured rewards low quality in the form of additional payments to remediate errors. Therefore, the logic model these constituencies are operating on states that creating greater efficiency is dependent upon improving the quality of care provided.

Both CMS and private insurers are actively developing and implementing incentive and reward programs to gain better value from their investments in health care services. CMS in particular is taking the lead in the movement to link pay to performance. To that end, Medicare will stop reimbursing hospitals for treating eight "reasonably preventable" conditions acquired in the facilities in 2008 (Zhang, 2007).

Addressing quality on case-by-case basis is an important component of the larger movement; however, it will not be enough in and of itself to generate the increased value purchasers, and consumers need to en-joy the level of care coverage they currently enjoy into the future. Further, targeting particular clinical conditions will not address the culture, leadership, and education issues in hospitals that have been the biggest barriers to quality and cost improvement programs (Blake, Kohler, Rask, Davis, & Naylor, 2006; Rask et al., 2007). Therefore, having both service-specific and holistic measures of hospitals' quality will allow for multipronged pay-for-performance programs that will accelerate the rate of positive change in the U.S. health care system. The analysis conducted herein can be ex-tended to explore the performance of particular markets and be used to modify payments to hospitals. For example, CMS could modify its Prospective Payment System's market-level adjustments to reduce payments to inefficient markets or lower quality.

The NQF's safe practices measures can serve the dual purposes of informing and evaluating hospitals performance based on the results of this analysis and others that have linked the scores to morbidity outcomes (Jha, Orav, Li, & Epstein, 2007). However, most of the facilities performed well on the NQF's safe practices measures as they are currently configured, thus reducing their discriminatory power. The collaboration managing the NQF program plans to increase the number of measures being used over time to address this limitation. The dynamic nature of the NQF and its collaboration with other major stakeholders, CMS in particular, ensure that the safe practices measures will be improved over time and be gathered on a regular basis. Therefore, the NQF's safe practices movement represents a major evolutionary step in the patient safety and quality arena but would benefit from further study in relationship to market and organizational characteristics.

Market and Organizational Factors

Three of the independent control variables—Herfindahl, HMO penetration rate, and having teaching hospital status—were significant and perform as expected in relationship to the X-inefficiency measure. Economic theory posits that greater competition will lead to greater organizational efficiency; therefore, a positive coefficient on the Herfindahl measure is consistent with that lemma. Previous research has generally found that in-creased HMO penetration rates are related to lower hospital cost inflation and utilization rates (Gaskin & Hadley, 1997; Mukamel, Zwanziger, & Tomaszewski, 2001; Robinson, 1991; Rosko, 2001b). There are fewer studies of teaching hospitals' X-inefficiency relative to other types of facilities, but given the significant amount of additional staffing at relatively low wages, it stands to reason that they should compare favorably (Rosko, 2004).

Two of the independent variables did not perform as expected—market share and ownership control. Generally, it is assumed that increased volume will lead to increased operational efficiency in the form of economies of scale (Fulton, Lasdon, & McDaniel, 2007). However, Tucker and Edmondson (2003) showed that in large hospitals communication and coordination within and across functional teams are very challenging and are prone to errors and service failures. Moreover, such systemic errors are persistent in the sense that workers do not learn from past failures. There may be significant diseconomies of scale or scope associated with hospital operations that lead to lower quality and, in

turn, less efficient operations. Therefore, these findings warrant further investigation to tease out the volume–quality–efficiency connections.

Although the ownership control variable did not perform as expected, general economic and agency theories contend that market forces and executive reward systems will lead for-profit organizations to operate in a more efficient manner (Anheier & Benner, 2003). There are two possible explanations for the counterintuitive results. The first is a statistical issue. The AHA taxonomy has most of the for-profit systems classified into one cluster. This may result in some confounding of the variables. An alternative explanation is that the organizational slack in nonprofit firms is so scarce that it is not possible for the leaders to operate inefficiently.

Practice Implications

As discussed herein, major initiatives are underway to both improve hospital quality metrics and release those results to external stakeholders. For health care practitioners, there will likely be a greater importance placed on performance with respect to quality outcomes (e.g., the NQF's safe practices scores, the Leapfrog Group, and other outlets) by both consumers and purchasers. This study empirically demonstrates to practitioners that the hospital value proposition holds, specifically with reference to the positive relationship between quality metrics and hospital efficiency. Efforts to improve quality and effectiveness while simultaneously working to reduce costs (and increase efficiencies) do not represent the zero-sum game. Practitioners facing increasing pressures to maximize value will be encouraged by this outcome.

The use of DEA technique can be used at the hospital or system level, with disparate units and outcomes using a similar methodology. Practitioners can use the tools to both compare performance across units and develop appropriate metrics for unit managers to apply during shifts. Given a set of inputs and specific outputs, efficiency frontiers can be developed for any number of outcomes, proving an opportunity for competitive advantage. Practitioners can use this knowledge to evaluate their own market, relative to their competitors, to increase profits or improve patients' perceptions of quality.

Conclusions

This analysis supports the relationship between efficiency and other expected factors, including quality, which serve to make the value proposition that policy-makers and purchasers are relying upon more tangible. As hospitals, and their policy oversight bodies, struggle with the challenges of quality and cost, the relationships between these variables must be explored in much greater detail. This analysis represents one of a number in the literature seeking to explore that dynamic, but unlike others, the value of taking a local perspective is shown to increase the explanatory power of the analysis. As the quality of data collection efforts increases and a universal expectation of reporting quality takes hold among hospital, we will see more studies of this kind in the literature. We have shown that using a market-by-market DEA has significant explanatory power in relationship to both institutional-level and market-level variables of interest—including the summated quality scores being promulgated by the NQF.

Limitations and Future Research

There are two main limitations to the current study. First, the findings from this study cannot be generalized to all U.S. hospitals because of the purposeful sampling frame that targeted large markets. In particular, urban versus rural location and differences in hospital size may lead to systematic resource constraints in small rural facilities and play an important role in both quality and efficiency. However, a study of the same NQF's safe practices by Rask et al. (2007) found no significant differences based on those dimensions.

The second major limitation is response bias in two forms. Better performing hospitals may view participating in the Leapfrog Group's survey as a means for capitalizing on a competitive advantage associated with their quality. The second form of response bias arises from the self-reporting feature of the surveying methodology used. Some hospitals may overstate the degree to which they have implemented the NQF's safe practices. The two forms of bias, to the extent they exist, both serve to diminish the statistical power of the regression analysis.

Nevertheless, this study was able to achieve significant explanatory power even with the potential biases. In future studies, higher response rates (that are essentially being mandated by CMS) and more objectively assessed measures of quality will increase the reliability and validity of research using similar approaches.

The CMS's efforts to systematically collect cost and quality data similar, and more granular, with that used in this study will make more rigorous analytic strategies possible. The more granular nature of the data will allow for detailed examination of the disease- and treatment-specific aspect of the health care system (e.g., Jha et al., 2005). Such future studies will be able to make significant contributions to the evidence-based medicine movement (Fonarow et al., 2007). Longitudinal studies of that data will allow researchers to study the cause-and-effect relationship between quality and efficiency. The use of CMSA markets as a unit of analysis is a natural component of such a study using hierarchical linear models over time.

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