

AN ABSTRACT OF THE THESIS OF

John Fielden Dickerson for the degree of Master of Science in Economics presented on June 19, 2000. Title: Behavioral Differences between Nonprofit and For-profit Hospitals: An Empirical Study.

Abstract approved: \_\_\_\_\_ *Redacted for Privacy* \_\_\_\_\_  
Laura S. Connolly

This paper examines the theoretical and empirical differences between the behavior of nonprofit and for-profit hospitals. Considerations are extended to include the possibility of collusion when hospitals make strategic choices. The operating objectives of the firms take into account price, quantity, and quality. Defining the quality of hospital care is discussed and applied to the empirical work. The model predicts nonprofit hospitals will provide a higher level of quality and a lower price than for-profit hospitals. Theoretically, under a collusive outcome for nonprofits, price will increase but the change in quality is indeterminate relative to a competitive, non-collusive outcome. The empirical section offers evidence of differences between nonprofit and for-profit hospital behavior. Nonprofit hospitals do provide higher quality and a lower price when compared to their for-profit rivals. It seems the competitive forces extend to the area of quality. There is evidence that increased competition between nonprofits fosters quality competition. From the for-profit perspective, quality competition appears to be provoked in markets where the for-profit competes more directly against nonprofits. This paper

## ABSTRACT - CONTINUED

provides theoretical and empirical analyses of hospital interactions and how these interactions change depending upon the type of control.

© Copyright by John Fielden Dickerson  
June 19, 2000  
All Rights Reserved

Behavioral Differences between Nonprofit and For-profit  
Hospitals: An Empirical Study

by

John Fielden Dickerson

A Thesis Submitted  
to  
Oregon State University

In partial fulfillment of  
the requirements for the  
degree of

Master of Science

Presented June 19, 2000  
Commencement June 2001

Master of Science Thesis of John Fielden Dickerson presented on June 19, 2000.

APPROVED:

*Redacted for Privacy*

---

Major Professor, representing Economics

*Redacted for Privacy*

---

Chair of Department of Economics

*Redacted for Privacy*

---

Dean of Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

*Redacted for Privacy*

---

John Fielden Dickerson, Author

## ACKNOWLEDGEMENTS

I thank all members of my graduate committee. Their conscientious guidance and assistance is greatly appreciated. In particular, I thank my major professor, Laura Connolly, for her insightful conversations, technical support, and enthusiastic encouragement.

## CONTENTS

	<u>PAGE</u>
1.0 INTRODUCTION.....	1
2.0 CHARACTERISTICS OF HOSPITALS.....	5
3.0 HOSPITAL PRODUCTION.....	8
4.0 THEORETICAL MODEL.....	11
4.1 FOR-PROFIT HOSPITALS.....	12
4.2 NONPROFIT HOSPITAL.....	13
4.2.1 NON-COOPERATIVE SOLUTION.....	14
4.2.2 COOPERATIVE SOLUTION.....	16
4.3 OTHER CONSIDERATIONS.....	21
5.0 EMPIRICAL MODEL AND TECHNIQUES.....	24
5.1 DESCRIPTION OF VARIABLES.....	27
5.2 DATA.....	32
5.3 EMPIRICAL RESULTS.....	32
5.3.1 PRICE REGRESSIONS.....	35
5.3.2 QUALITY REGRESSIONS.....	39
6.0 CONCLUSIONS.....	43
BIBLIOGRAPHY.....	45
APPENDIX.....	49

## LIST OF FIGURES

<u>FIGURE</u>		<u>PAGE</u>
4-1	HOSPITAL AVERAGE COST CURVES AND QUALITY.....	19
4-2	QUALITY-QUANTITY FRONTIER.....	20



## LIST OF TABLES

		<u>PAGE</u>
<u>TABLE</u>		
1	TABLE 1: SHARE OF HOSPITAL TYPE IN EACH HSA AND HSA DEFINITIONS.....	29
2	TABLE 2: DESCRIPTIVE STATISTICS.....	33
3	TABLE 3: ESTIMATES OF PRICE EFFECTS: PARKS METHOD.....	36
4	TABLE 4: ESTIMATES OF QUALITY EFFECTS: FULLER METHOD.....	40

# Behavioral Differences between Nonprofit and For-profit Hospitals: An Empirical Study

## 1.0 INTRODUCTION

Health care is currently a prevailing economic and political issue in the United States and in many other nations. The United States and other countries experienced a rapid growth in health care spending over the past thirty years. The rapid growth in spending spurred interest in this sector and led to the emergence of Health Economics as a distinct specialty within Economics. Annual expenditure on personal medical services increased from 5% of GNP in 1965 to 12.1% of GNP in 1995 with total medical spending accounting for 13.7% of GNP in 1995 [Henderson (1999), p. 236].

The health care sector experienced substantial changes beyond changes in spending. Private health insurance coverage has been gradually declining over the years, and thus, the number of uninsured is steadily climbing. This fact combined with a surge in spending and other changing characteristics in the dynamic health care industry fostered public concerns that the system needs reform. While the issues of healthcare reform cover a wide gamut, the universal concerns focus on three broad categories: quality, access, and affordability.

The purpose of this paper is to assess price and quality across hospitals. More specifically, it theoretically and empirically examines the varying level of quality and price between hospitals with different control structures. When

comparing for-profit with nonprofit hospitals, theory suggests nonprofit hospitals provide a higher level of quality than do their for-profit counterparts. The premise for this theory lies in the nonprofit hospital's zero-profit constraint. Nonprofit hospitals are technically allowed to derive profit from their activities, typically referred to as excess revenue, but do not have shareholders to benefit and are not allowed to distribute this profit to managers. Excess revenue is dispersed back into continuing and expanding operations. Theory proposes this channeling of funds allows a financial tool to improve the level of quality for a given hospital. The following empirical work strives to test the proposition that nonprofit hospitals provide a higher level of quality and provide lower cost care than their for-profit competitors.

There is a wide range of literature available for Healthcare Economics, nonprofit institutions, and competition between firms. The purpose of this paper narrows the scope of relevant literature primarily to those works focusing on the quality of healthcare, nonprofit behavioral functions, and empirical studies of hospitals as firms. When discussing the quality of healthcare, discussions divide into two distinct areas: the general quality of the hospital (often associated with prestige) and the quality received by patients.

A wealth of information exists addressing these topics. This paper embraces the issue of quality in the broadest sense when discussing the theoretical model. That is, quality reduces to a single, well-defined variable in order to facilitate the purpose of this paper. Readers interested in a survey of the quality of

care should see Folland's (1997) text. More important to an empirical study of hospitals is the measuring of quality. The foundations for capturing a representation of quality in regression work come from publications by Luft and colleagues (1990) and Haas-Wilson (1990).

These works use interesting techniques to measure quality. Such measurable factors as teaching status, transfer and referral patterns, medical school affiliation, and various indexes of outcome indicate quality. These factors appear in many modern publications relying on observations of the level of quality. The empirical work contained within this paper borrows some of these measures and expands upon them by introducing some new measures of quality, such as capital expenditure per discharge.

The objective function of a nonprofit institution is not straightforward. The nonprofit institution operates as utility-maximizer but the origins of the utility function are not clear. Primary guidance for the objective function used herein comes from the model proposed by James (1983) and a later extension of this model by Netz (1998). The model proposed within this paper applies these models to nonprofit hospitals. Previous economic work by Newhouse (1970), Pauly and Redisch (1973), and Hirth (1999) applied extensions of these models to the hospital industry and also helped guide the following empirical and theoretical work.

Rigorous empirical analysis of hospitals and hospital competition proves to be difficult because of hospitals' unique multi-product nature. The empirical model and the techniques used in this study rely on previous work that addresses the

issues of price, output, and competition. Barton and Sherman (1984), Lynk (1995), Sacher and Silvia (1998), and Vita and Sacher (1999) provide foundations for the empirical model used, as well as techniques for representing price and output.

Also, the works by Luft et al. (1986), Robinson et al. (1987), Noether (1988), and Schiff and Weisbrod (1993) assist with the considerations of competition between hospitals. More specifically, they address the theoretical interactions between hospitals and the characteristics of the hospital market that become strategic variables. The following work utilizes some of these techniques but places more of an emphasis on the quality of care.

## 2.0 CHARACTERISTICS OF HOSPITALS

The modern U.S. hospital emerged at the beginning of the 20<sup>th</sup> century. Most hospitals organized as nonprofit institutions with the main purpose of providing free care to the poor. The majority of the population considered the quality of care received at nonprofit hospitals to be quite poor. Those who were able to pay for health care avoided nonprofit hospitals and helped to support the emergence of the for-profit hospital.

Urbanization and the rise of the urban middle class fostered the growth of hospitals as a whole while the increasing incomes of the urban middle class helped to increase the number of for-profit hospitals. The movement towards for-profit hospitals was short lived, however. Financial difficulties stemming from the Great Depression and the government's preferential treatment to nonprofit hospitals disadvantaged the growth of for-profit hospitals. Nonprofit became the favored form because this type of hospital could accept tax-deductible, charitable contributions, they received construction subsidies under the Hill-Burton Act, and some state legislatures even made for-profit hospitals illegal [Henderson (1999), pp. 237-241].

The continued dominance of nonprofit hospitals in the U.S. can be explained with three common theories. First, consumers have great difficulty evaluating the quality of medical care across hospitals and trust institutions that do not face the profit motive [Arrow (1963)]. Second, since profit-maximizing firms

will not undertake activities where marginal revenue is less than marginal cost, for-profit hospitals would not engage in many aspects of teaching, research, or public health [Weisbrod (1989)]. This idea supports the government's financial favoritism towards nonprofit hospitals. Finally, the nonprofit form allows for the most benefits for physicians who, in turn, promote the dominance of the nonprofit hospital [Pauly and Redisch (1973)].

Hospitals are classified according to the length of stay, size (usually measured in number of beds), and type. Those hospitals where patient stays are less than 30 days are classified as short stay while long stay hospitals are for those stays greater than 30 days. The major types of hospitals include community (both teaching and non-federal, general hospitals), mental, tuberculosis and other respiratory disease, and other special hospitals. There are also federally controlled hospitals.

Community hospitals are defined as short-stay hospitals, providing not only general services but also specialized care. Over 85% of all non-federal hospitals are classified as community hospitals. Their type of control further classifies community hospitals. Non-profit hospitals account for 60% of US community hospitals and control 70% of available beds. For-profit hospitals represent 13.6% of all community hospitals and control 10.8% of all beds. The remaining community hospitals are government owned, usually by the state, and typically provide services in rural communities. Approximately 20% of all hospitals in the US have an affiliation with one or more of the nation's 125 medical schools and

sponsor at least one residency training program. Of these, only 388 hospitals are members of the Council of Teaching hospitals of the Association of American Medical Colleges. They receive government subsidies to fund teaching and research [Henderson (1999)].

The general categories of services provided by hospitals differ between the classifications. Almost all hospitals provide primary care, which is preventive and curative in nature. The larger, community hospitals provide secondary care in addition to primary care. Secondary care consists of common medical and surgical procedures. Both outpatient and inpatient procedures are available in secondary care hospitals. Large, university affiliated hospitals and other specialized hospitals provide tertiary care, consisting of transplants, heart procedures, etc., as well as, primary and secondary care.

Since 1970, the nominal cost per day for inpatient days has increased from \$74 to \$931 while the cost per stay increased from \$605 to \$6,230 [Sherman et al. (1997)]. Hospital systems move towards controlling inpatient stays, the most expensive episode of care. Hospitals' efforts to decrease inpatient hospital stays accounted for the trend of falling inpatient utilization and increased outpatient stays. As a result, outpatient facilities, such as freestanding ambulatory care facilities, surgical centers, physical therapy centers, and diagnostic imaging centers have gained popularity. This work focuses on short stay, general hospitals as is discussed in section 5.2. This narrows the relevant competitors for a given hospital.



### 3.0 HOSPITAL PRODUCTION

The hospital industry is a difficult arena for economic analysis. Hospitals certainly fulfill the requirements for a multi-product firm by providing a multitude of services and products. Dissention arises, however, when beginning to define their products and services. An aspirin is clearly an aspirin and a splint is nothing less than a splint but when it comes to delineating the criteria for general hospital production, a rather simple yet complex question arises. What do hospitals produce?

Ideally, hospitals provide a better quality of health for their patients. If someone goes to a hospital and exchanges money for a service, then they expect to leave the hospital in better health than when they arrived. Those patients who do not receive a better level of health must be considered as well. Assuming the doctor did everything within the confines of her training and within her power to help the patient, it is not typically argued that the patient received an inferior product. So where does this leave the conclusion to defining hospital output? It is apparent that solely measuring discharges is inadequate for capturing the purpose and efforts of hospitals.

Measuring and weighting for quality, however, is empirically difficult. Therefore, representing the true service of hospitals proves to be an arduous task. Previously used techniques try to capture the overall quality in addition to the quality received by patients. The average length of stay per patient and the ratio of

fully staffed beds to total beds are examples that are positively related to the patient's perspective of quality. Fully staffed beds are those beds that have full staffing resources available for them. While this is not true in every case, the argument generally assumes cost cutting efforts take precedence within a hospital and therefore, patients may lose some level of personal care [Luft et al. (1990)].

The overall quality of a hospital is often associated with the prestige of that hospital within the community (geographical or specialty). The prestige of a hospital depends upon the level of technology employed by the hospital, the quality of physicians, the research successes, the amount of government grants, etc. Measuring the level of these items may partly capture the prestige or quality of the hospital. Section 5.2 addresses these issues in more detail and further explains the techniques used within this paper.

The unique nature of hospitals has led to substantial effort in capturing the quality of care provided. The consequences of poor quality can be very severe to the consumer. At the same time, the effort and time required to research quality is very costly for consumers. Arrangements that are intended to reduce their search costs include licensure and certification, the threat of malpractice suits, codes of ethics, and quality assurance schemes that are either mandatory or voluntary [Sherman et al. (1997)]. Methods that are founded in economic theory are used to measure quality of care for hospitals. Their implications do impact policy issues through reports and surveys provided by researchers but are not usually analyzed by a majority of policy makers directly [Luft et al. (1990)].

Due to the existence of third-party payers, many consumers do not directly consider price for the majority of their decisions. Hospitals rely heavily on physician referrals in order to attract patients. Physicians are typically attracted to higher quality institutions because they are primarily concerned with the well being of their patients. Also, when consumers do directly consider which hospital to attend, quality is a major determinant.<sup>1</sup>

As mentioned previously, defining the product market is a difficult proposition. In addition to quality, other hospital characteristics, such as location and bed availability, become dominant factors for specific situations. For example, if a consumer is suffering from heart failure or a severed limb, they will be primarily interested in location and space availability while someone interested in non life-threatening surgery will be more concerned with quality. In general, quality is a major factor and thus, is an important measure of hospitals. The following discussion assumes a product definition of non-specialized, inpatient procedures.

---

<sup>1</sup>For a more detailed discussion about the price-elasticity of health care services and related empirical work, please see Luft et al. (1986).

#### 4.0 THEORETICAL MODEL

Analysis of the hospital market must account for the differences in operating objectives across different types of hospitals. Non-profit and for-profit hospitals account for the majority of the market but while these types of control are similar in services provided, they differ in their underlying objective functions. Both types of institutions strive to maximize some form of utility. In the case of the for-profit hospital, the decision-makers behave as profit-maximizers, which is a specific form of a standard utility function, and the analysis proves to be rather straightforward.

The non-profit hospital, however, is more difficult to analyze because there is no well-defined objective function. I use a model where hospital decision-makers strive to maximize utility subject to a zero-profit constraint [James (1983)]. The model is uniform with the goals non-profit hospitals: to provide easily accessible healthcare and to provide a high level of quality of care [Newhouse (1970)]. This theoretical model analyzes the differences in prices and quality dependent upon the type of control in a situation where firms have a definable objective function. The effect of cooperation on prices and quality is also considered.

An important complication demands attention before continuing. It is uncertain who the utility function represents. Economic research and theory predominantly suggests that either hospital administrators or physicians with staff

privileges are the main decision-makers behind the objective function. I assume the decision-maker behind the utility function strives to further the mission of the hospital and to some extent, his own career. I accept the idea that it is most satisfying to manage a successful hospital but do not assume that he strives to maximize his own financial well-being or "slack" time.<sup>2</sup>

#### 4.1 FOR-PROFIT HOSPITAL

The demand for hospital services is given by  $Q = Q(P, K)$ , where quantity decreases in the hospital's own price and quantity increases in its own quality. Total costs are a function of the total number of discharges ( $Q$ ) and the quality of the hospital ( $K$ ),  $C = C(Q, K)$ , with standard properties:  $\partial C/\partial Q$ ,  $\partial C/\partial K$ ,  $\partial^2 C/\partial K^2$ , and  $\partial^2 C/\partial Q^2 > 0$ . The cost of increasing each output is increasing at an increasing rate. Quality is partly perceived through the level of care per patient therefore, the more discharges, the more costly it is to increase quality ( $\partial^2 C/\partial Q\partial K > 0$ ).

In a non-cooperative setting, hospital decision-makers at a for-profit hospital strive to maximize the individual hospital's profit function. That is, the maximization problem is as follows:

$$(1) \text{Max}_{P, K} \Pi = PQ(P, K) - C[Q(P, K), K].$$

---

<sup>2</sup> For further discussion about the underlying decision-makers behind the utility function, please see the works by Newhouse (1970), Pauly (1987), and Hirth (1999).

The first order conditions with respect to price and quality are given by

$$(2) \quad \partial\Pi/\partial P = Q(P, K) + P\partial Q/\partial P - \partial C/\partial Q * \partial Q/\partial P = 0$$

$$(3) \quad \partial\Pi/\partial K = P\partial Q/\partial K - \partial C/\partial Q * \partial Q/\partial K - \partial C/\partial K = 0.$$

These equations yield the standard conditions for profit-maximizing firms: marginal revenue is equal to marginal cost, with respect to both quantity and quality. Since this type of hospital does not face a zero-profit constraint per se, they benefit directly from increasing profit. Entry and exit drive competitive firms' profit to zero in the long run. For-profit firms operate in order to maximize profit in the short run or to maximize profit given that they are able to exercise some market power.

#### 4.2 NONPROFIT HOSPITAL

Utility of hospital administrators in a nonprofit hospital is assumed to be a function of number of discharges (Q) and quality of the hospital (K):  $U = U(Q, K)$ .<sup>3</sup> The following theoretical model borrows elements from the model used by Netz (1998) in her analysis of universities. For simplicity, assume the utility functions are identical across nonprofit hospitals, and assume the utility function has the standard properties:

$\partial U/\partial Q > 0$ ,  $\partial U/\partial K > 0$ ,  $\partial^2 U/\partial Q^2 < 0$ , and  $\partial^2 U/\partial K^2 < 0$ . Identical to the for-profit hospital, except for the consideration of rivals, the demand for hospital services is given by  $Q_i = Q(P_i, P_j, K_i, K_j)$ , where quantity decreases in the hospitals own price

---

<sup>3</sup> For a primary source of nonprofit models, please see the work by James (1983).

$(P_i)$ , increases in rivals' prices ( $P_j$ ), increases in its own quality ( $K_i$ ), and decreases in its rivals' quality ( $K_j$ ).

Total costs are a function of the total number of discharges ( $Q$ ) and the quality of the hospital ( $K$ ),  $C = C(Q, K)$ , with standard properties:  $\partial C/\partial Q$ ,  $\partial C/\partial K$ ,  $\partial^2 C/\partial K^2$ ,  $\partial^2 C/\partial Q^2$ , and  $\partial^2 C/\partial Q\partial K > 0$ . The cost of increasing each unit of output is increasing at an increasing rate. Also, the more discharges, the more costly it is to increase quality.

#### 4.2.1 NON-COOPERATIVE SOLUTION

When hospitals make decisions independently, there is no concern about their rivals' actions. Hospital decision-makers only account for the impact upon their own hospital when choosing quality, quantity, and price. Because hospital decision-makers assume their rivals will not react to their choices, they are behaving as Nash oligopolists. Suppressing the non-choice parameters and the  $i$  subscript for notational ease, the maximization problem for non-profit hospitals is as follows:

$$(4) \quad \text{Max}_{P, K} U(Q(P, K), K) \\ \text{s.t. } \Pi = 0$$

where  $\Pi = PQ(P, K) - C(Q(P, K), K)$ . Letting  $\lambda$  be the Lagrange multiplier and  $L$  be the Lagrangian maximand, the first-order conditions are given by:

$$(5) \quad \partial L/\partial P = \partial U/\partial Q * \partial Q/\partial P + \lambda Q(P, K) + \lambda P \partial Q/\partial P - \lambda \partial C/\partial Q * \partial Q/\partial P = 0$$

$$(6) \quad \frac{\partial L}{\partial K} = \frac{\partial U}{\partial Q} \frac{\partial Q}{\partial K} + \frac{\partial U}{\partial K} + \lambda P \frac{\partial Q}{\partial K} - \lambda \frac{\partial C}{\partial Q} \frac{\partial Q}{\partial K} - \lambda \frac{\partial C}{\partial K} = 0$$

$$(7) \quad \frac{\partial L}{\partial \lambda} = PQ(P,K) - C(Q(P,K), K) = 0.$$

Solving (5) and (6) gives the following equilibrium conditions:

$$\frac{\frac{\partial U}{\partial Q} \frac{\partial Q}{\partial P}}{\frac{\partial U}{\partial Q} \frac{\partial Q}{\partial K} + \frac{\partial U}{\partial K}} = \frac{Q(P,K) + P \frac{\partial Q}{\partial P} - \frac{\partial C}{\partial Q} \frac{\partial Q}{\partial P}}{P \frac{\partial Q}{\partial K} - \frac{\partial C}{\partial Q} \frac{\partial Q}{\partial K} - \frac{\partial C}{\partial K}}$$

$$\text{or} \quad \frac{\frac{\partial U}{\partial Q} \frac{\partial Q}{\partial P}}{Q(P,K) + P \frac{\partial Q}{\partial P} - \frac{\partial C}{\partial Q} \frac{\partial Q}{\partial P}} = \frac{\frac{\partial U}{\partial Q} \frac{\partial Q}{\partial K} + \frac{\partial U}{\partial K}}{P \frac{\partial Q}{\partial K} - \frac{\partial C}{\partial Q} \frac{\partial Q}{\partial K} - \frac{\partial C}{\partial K}}.$$

While not apparent at first, these equations give the familiar conditions for utility-maximization. The numerators in the second form represent the marginal utility received from P and K respectively, while the denominators indicate the marginal profit with respect to P and K, consistent with the condition that marginal utility per dollar be equal across the goods. The first form shows the condition that the marginal rate of substitution must be equal to the ratio of prices, where prices are measured as the effects on profits.

The comparison of how a utility-maximizing agent sets P and K relative to the levels chosen by a profit-maximizing agent is important for continuation. The constrained first-order condition for the price of hospital care and for the level of quality show that the optimal level depends not only on marginal revenue and marginal cost with respect to those variables, but that it also depends on marginal utility. Marginal utility from quality is positive, so a utility-maximizing agent will choose a level of quality that is above the profit-maximizing level.<sup>4</sup> Marginal

---

<sup>4</sup>  $\Pi_K$  is negative when evaluated at the optimum.



utility from price is negative so the price charged by a utility-maximizing agent will be below the profit-maximizing level.<sup>5</sup> A utility maximizing administrator will choose a price below its for-profit counterpart and provide a higher level of quality.

#### 4.2.2 COOPERATIVE SOLUTION

What is the impact on this analysis if the non-profit hospitals jointly determine their level of price and quality? If the hospitals in question are for-profit institutions, they would jointly maximize profit akin to familiar economic standards. With non-profits, however, utility is a function of quality and quantity. If the decision-makers agree to decrease price, utility increases with an increase in quantity but at the expense of depleting excess revenue. In turn, monies available for expanding the level of quality diminish. This tightening of the zero-profit constraint must be considered. For simplicity, assume there are two hospitals cooperating and the hospitals maximize the sum of their utility functions. Rewriting the maximization problem as a function of the choice variables, P and K, the maximization problem can be written as:

$$\begin{aligned}
 (8) \quad & \text{Max}_{P, K} U_i(Q_i(P_i, P_j, K_i, K_j), K_i) + U_j(Q_j(P_j, P_i, K_j, K_i), K_j) \\
 & \text{s.t. } P_i Q_i(P_i, P_j, K_i, K_j) - C_i(Q_i(P_i, P_j, K_i, K_j), K_i) = 0 \\
 & P_j Q_j(P_j, P_i, K_j, K_i) - C_j(Q_j(P_j, P_i, K_j, K_i), K_j) = 0.
 \end{aligned}$$

Since this is a joint maximization problem and the firms are identical, a single price and quality will be chosen. The subscripts are retained, however, in deriving the

---

<sup>5</sup>  $\Pi_p$  is positive when evaluated at the optimum

first-order conditions so that the cross-price and cross-quality effects are clearly identified. Thus, the first order conditions can be written as:

$$(9) \quad \begin{aligned} \partial L / \partial P = & \partial U_i / \partial Q_i * \partial Q_i / \partial P_i + \partial U_i / \partial Q_i * \partial Q_i / \partial P_j + \partial U_j / \partial Q_j * \partial Q_j / \partial P_j + \\ & \partial U_j / \partial Q_j * \partial Q_j / \partial P_i + \lambda_i((Q_i(P_i, P_j, K_i, K_j), K_i) + P_i \partial Q_i / \partial P_i + \\ & P_i \partial Q_i / \partial P_j - \partial C_i / \partial Q_i * \partial Q_i / \partial P_i - \partial C_i / \partial Q_i * \partial Q_i / \partial P_j) + \\ & \lambda_j((Q_j(P_j, P_i, K_j, K_i), K_j) + P_j \partial Q_j / \partial P_j + P_j \partial Q_j / \partial P_i - \partial C_j / \partial Q_j * \partial Q_j / \partial P_j - \\ & \partial C_j / \partial Q_j * \partial Q_j / \partial P_i) = 0 \end{aligned}$$

where L denotes the Langrangian maximand and  $\lambda_i$  and  $\lambda_j$  are the Lagrange multipliers for the zero-profit constraint for each hospital. If the outcome is completely symmetric, such that both hospitals charge the same price and have the same quality, then  $P_i = P_j$ ,

$K_i = K_j$ , and  $\lambda_i = \lambda_j$ , and the first-order condition can be simplified to

$$(10) \quad \begin{aligned} \partial L / \partial P = & \partial U_i / \partial Q_i * \partial Q_i / \partial P_i + \partial U_i / \partial Q_i * \partial Q_i / \partial P_j + \lambda_i((Q_i(P_i, P_j, K_i, K_j), K_i) + \\ & P_i \partial Q_i / \partial P_i + P_i \partial Q_i / \partial P_j - \partial C_i / \partial Q_i * \partial Q_i / \partial P_i - \partial C_i / \partial Q_i * \partial Q_i / \partial P_j) = 0. \end{aligned}$$

To compare the cooperatively chosen  $P, P^c$ , to the non-cooperative outcome,  $P^{nc}$ , I evaluate the first-order equation for  $P^c$ , equation (10), at the level  $P^{nc}$ . From equation (5),  $\partial U_i / \partial Q_i * \partial Q_i / \partial P_i + \lambda_i[Q(P_i, K_i) + P_i \partial Q_i / \partial P_i - \partial C_i / \partial Q_i * \partial Q_i / \partial P_i]$  is equal to zero at the non-cooperative price so

$$(11) \quad \begin{aligned} \partial L / \partial P|_{P = P^{nc}} = & \partial U_i / \partial Q_i * \partial Q_i / \partial P_j + \lambda_i \partial Q_i / \partial P_j (P_i - \partial C_i / \partial Q_i) \\ = & \partial Q_i / \partial P_j [\partial U_i / \partial Q_i + \lambda_i (P_i - \partial C_i / \partial Q_i)]. \end{aligned}$$

Because demand for one hospital increases in the other's price,  $\partial Q_i / \partial P_j$  is positive, and the sign of equation (11) depends on the term in the brackets. The term in

brackets is positive, as shown by rewriting a hospital's first-order condition in a non-cooperative setting, equation (5), as

$$(12) \quad \partial U_i / \partial Q_i + \lambda_i (P_i - \partial C_i / \partial Q_i) = -\lambda_i Q_i / (\partial Q_i / \partial P_i) > 0.$$

The inequality holds because  $\lambda_i > 0$ ,  $Q_i$  is positive assuming an interior solution, and  $\partial Q_i / \partial P_i < 0$ . Therefore, beginning at each hospital's non-cooperative level of price, the cooperative first-order condition is positive, indicating that the price should be increased to reach the cooperative optimum. As in the non-cooperative setting, the price will not rise as far as the profit-maximizing price, because the hospitals will again face a trade-off; a higher price allows the hospital to invest in quality, but also reduces the number of patients, directly reducing utility. Raising a rival's price, however, has a positive effect on both  $Q_i$  and the excess revenue that hospital receives so the cooperative price will be higher than the non-cooperative price.

Taking the first-order condition with respect to quality and simplifying yields

$$(13) \quad \partial L / \partial K = \partial U_i / \partial Q_i * \partial Q_i / \partial K_i + \partial U_i / \partial Q_i * \partial Q_i / \partial K_j + \partial U_i / \partial K_i + \lambda_i (P_i \partial Q_i / \partial K_i + P_i \partial Q_i / \partial K_j - \partial C_i / \partial Q_i * \partial Q_i / \partial K_i - \partial C_i / \partial Q_i * \partial Q_i / \partial K_j - \partial C_i / \partial K_i) = 0.$$

To compare the cooperatively chosen  $K$ ,  $K^c$ , to the non-cooperative outcome,  $K^{nc}$ , I evaluate the first-order condition for  $K^c$ , equation (13), at  $K^{nc}$ . From equation (6),  $\partial U / \partial Q * \partial Q / \partial K + \partial U / \partial K + \lambda [P \partial Q / \partial K - \partial C / \partial Q * \partial Q / \partial K - \partial C / \partial K]$  is equal to zero at the non-cooperative outcome so equation (13) can be rewritten as

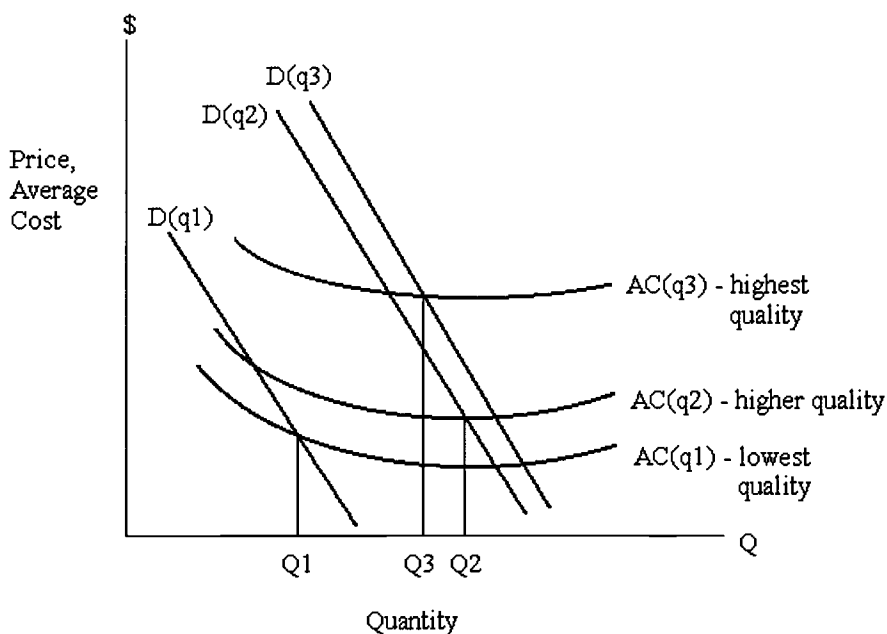
$$(14) \quad \partial L / \partial K \Big|_{K=K^{nc}} = \partial Q_i / \partial K_j [\partial U_i / \partial Q_i + \lambda_i (P_i - \partial C_i / \partial Q_i)].$$

The term  $\partial Q_i / \partial K_j$  is negative because one hospital's demand will fall in response to a rival's increase in quality. Once again, I am interested in the sign of the terms in brackets. From equation (6), the term in brackets is rewritten as

$$(15) \quad [\partial U_i / \partial Q_i + \lambda_i (P_i - \partial C_i / \partial Q_i)] = \lambda [(\partial C_i / \partial K_i) / (\partial Q_i / \partial K_i)] - \partial U_i / \partial K_i / (\partial Q_i / \partial K_i).$$

While the first term and the second term on the right-hand-side are both positive, the sign for the entire term of interest is indeterminate. Some intuition can

FIGURE 4-1: HOSPITAL AVERAGE COST CURVES AND QUALITY

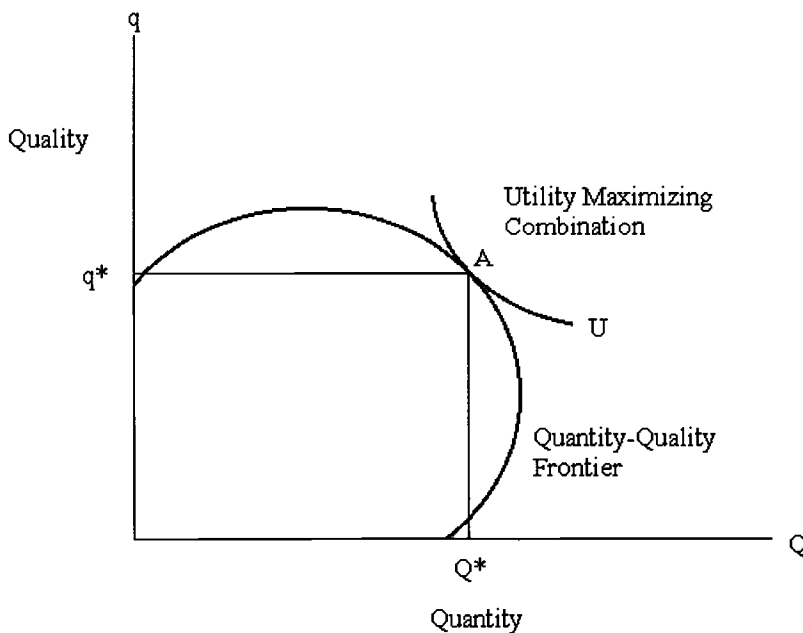


be derived from this, however. In a cooperative setting, the individual hospital's incentive is to set the level of quality above the cooperatively chosen level. This is similar to the Bertrand Paradox but in reverse. If one hospital deviates from the

cartel agreement, they would be able to capture a larger market share. Increases in quality come at a higher cost, however. Quantity will drop off as quality surpasses some optimum, as is seen in figure 4-1. Quantity falls from  $Q_2$  to  $Q_3$  given increased levels of quality. After some point, increased expenditures on quality will result in small or negligible increases in demand. Thus, consumers will not continuously finance the cost of quality advancements.

Given the tradeoff between quality and quantity, a hospital is forced to operate within their quality-quantity frontier. Figure 4-2 depicts this frontier and shows that hospital decision-makers will try to locate on the highest possible indifference curve given the quality-quantity frontier (point A). A single hospital

FIGURE 4-2: QUANTITY - QUALITY FRONTIER



could deviate from the previously mentioned cartel agreement by shifting their quality-quantity frontier outwards. One way to do this is to find another source of funding besides pricing. If, for instance, a hospital is able to gain additional funding through grants and donations, they will be able to shift their frontier outwards. Thus, competition may take the form of lobbying for government funding or appealing to private donors.

Since the sign is ambiguous, the optimal cooperative level may be higher than the non-cooperative level. If the quality of health care necessary to maximize benefit to the community is above that level fundable by consumers and the government, then health care may be treated like a public good. In this case, "cooperation" may take the form of joint lobbying for a single community.

#### 4.3 OTHER CONSIDERATIONS

Several real-world characteristics of the hospital market make this model less than realistic. First, by clustering all prices and quantities into single aggregates, one loses the effects different procedures and segments of the population have on a non-profit's utility function. One of the missions of non-profit hospitals is to provide care to those in particular need (e.g. those who cannot afford medical care). The decision-makers may gain an increased level of utility by providing the above-mentioned type of care. Also, many procedures and services are considered more prestigious than others. Providing medically advanced procedures to a select few patients may help foster a hospital's reputation and

prestige and thus, directly affect the utility of the decision-makers as well as indirectly increasing it by increasing the demand for the hospital [Lee (1971)]. Along the same lines, the increased prestige may encourage new donations and thus, increase the hospital's capacities. This is partly accounted for in the quality variable but some of this effect is lost in the aggregation process.

Also, the characteristics of the hospital market make the issue of price a bit more uncertain. Empirical research and intuition suggest the demand is relatively price inelastic for hospital services, especially inpatient, high resource allocation procedures [Pauly (1983) and Robinson et al. (1988)]. The predominance of third party payers make patients rather insensitive to price, however, the prevalence of low cost bidding for contracts has injected some degree of newfound price competition into the system. If patients are rather price insensitive, then non-profit hospitals may find it is in their best interest to exercise market power when possible and use the high profits to further enhance the quality and reputation of the hospital.

Because the increased prices will not substantially deter quantity, non-profits may choose prices similar to the prices set by for-profit hospitals. In summary, if non-profit hospitals collude among themselves, a higher price will be witnessed than the non-collusive outcome. This excess revenue may be pumped back into the hospital in the form of expansion and increased quality. The level at which hospitals collude is uncertain. Since the market contains both for-profits and nonprofits, collusion between types must be considered.

In terms of price, a nonprofit will choose a price that maximizes utility subject to the quantity-quality frontier as mentioned above. Since quantity enters into the objective function, the nonprofit will not have an incentive to jointly determine price with for-profit hospitals. In terms of quality, since quantity decreases in rivals' level of quality, for-profits will not want to collude with nonprofits. As a nonprofit hospital gains excess profit, it will be used to finance further quality enhancements. Because for-profits are responsible to shareholders, they will be unable or unwilling to match these advancements.

The existence of a large dominance of for-profits in a market may allow non-profit hospitals to exercise additional market power. If price is high, they may be able to set a price above nonprofit equilibrium without substantial loss of patients. Such a situation would allow nonprofits to provide a higher level of quality without sacrificing quantity assuming that increased profits benefit the hospital directly. That is, that these profits are used directly to enhance the quality characteristics of a hospital. This could also be used to support the idea of the "medical arms race" referred to in much of modern, medical literature.



## 5.0 EMPIRICAL MODEL AND TECHNIQUES

To identify the equilibrium price effects I use an empirical specification that borrows elements from previous works focused on capturing the price effects of hospital mergers.<sup>6</sup> The estimating equation is assumed to take the following form:

$$(16) P_{it} = P(W_{it}, Z_{it}, K_{it}, F_{it}) + \varepsilon_{it}$$

where  $P_{it}$  is the price of hospital  $i$  at time  $t$ ,  $W_{it}$  is a vector of demand shifters (e.g. income),  $Z_{it}$  is a vector of input prices,  $K_{it}$  is a vector of quality variables,  $F_{it}$  is a vector of dummies representing differences in hospitals' objective functions (e.g. non-profit); and  $\varepsilon_{it}$  is an error term with properties described below. This equation for price depicts quality as being predetermined. I believe quality ( $K$ ) is exogenous by the assumption that price from previous periods ( $T-1$  to  $T-n$ ) impacts current ( $T$ ) quality but current price does not. Quality thus takes the following form:

$$(17) K_{it} = K(P_{i,t-1}, F_{it}) + \varphi_{it}$$

where  $P_{i,t-1}$  is the lag of price,  $F_{it}$  is the type of control, and  $\varphi_{it}$  is a random error term.

In the estimation, two measures of price are considered: the average net revenue per discharge for all inpatients and the average net revenue per discharge for those patients privately insured and those who fall into a gray area of uninsured patients. This second group of people includes those patients who are uninsured

---

<sup>6</sup> For empirical work that uses similar techniques, please see the works by Barton and Sherman (1984), Schumann et al. (1992), and Vita and Sacher (1999).

but are not included in county indigent programs. For the remainder of this paper the combination of these two groups will be collectively referred to as privately insured. I use two prices to attempt to isolate those patients who pay directly or are not covered by Medicare or MediCal. A hospital would be more able to manipulate price with this type of consumer.

Unlike the classical linear model, the error covariance matrix of pooled data models may be non-diagonal. In equation (14), there are 335 cross-sectional units (hospitals) observed over 12 periods. I anticipate serial correlation to be an issue because of the transitional nature of several of the variables and because the adjustment process of price is not instantaneous. There may be heteroskedasticity because the intensity of procedures undertaken varies greatly between hospitals. There is probably greater variation in price as resource intensity increases. I use two types of error structures to account for the pooled nature of the data. The random error in the error components model has the following decomposition:

$$(18) \quad \varepsilon_{it} = v_i + e_t + u_{it}, \quad i = 1, 2, \dots, N; t = 1, 2, \dots, T$$

where the errors  $v_i$ ,  $e_t$ , and  $u_{it}$  are independently distributed with zero means and positive finite variances  $\sigma_v^2$ ,  $\sigma_e^2$ , and  $\sigma_{uit}^2$ .

$u_{it}$  is the traditional error term unique to each observation,  $v_i$  is an error term representing the extent to which the intercept of the  $i$ th cross-sectional unit differs from the overall intercept, and  $e_t$  is an error term that represents the extent to which the  $t$ th time period's intercept differs from the overall intercept. The Fuller-Battese method is used to estimate this model. The variance components are estimated by

the fitting-of-constants method, and the regression parameters are estimated with generalized least squares.<sup>7</sup>

The random effects model is preferred because the data represents a small fraction of a larger population in the context that only California's nonprofit and for-profit hospitals are included in the regressions. Using the random effects model, however, assumes the random errors associated with each cross-section unit are uncorrelated with the other regressors [Kennedy (1998), p. 227]. A Hausman test rejects the null hypothesis of no correlation between regressors and thus, no misspecification for the price equation. Therefore, the coefficient estimates may be biased. For the quality regressions, however, the Hausman test fails to reject the null hypothesis of no correlation between regressors so the equations are only estimated using the Fuller-Battese method.

I also use the Parks method to estimate the price equation, equation (16), which assumes a first-order autoregressive error structure with contemporaneous correlation between cross sections.<sup>8</sup> This method specifies errors as

$$(19) \mu_{it} = \rho_i \mu_{i,t-1} + \delta_{it}$$

where  $\delta_{it}$  is uncorrelated across observations and  $\rho_i$  is a parameter that determines the correlation properties of  $\mu_{it}$ . This model accounts for the previously discussed correlation and adjusts for the biased coefficient estimates produced by the Fuller method. Comparisons between the parameter estimates are made in section 5.3.

---

<sup>7</sup> For a complete description of this technique, please see SAS Institute (1993) pp. 879-881.

<sup>8</sup> This technique is described in detail in Greene (1997) p. 687.

## 5.1 DESCRIPTION OF VARIABLES

PRICE - Each calendar quarter, California-licensed hospitals file a Financial Data Report with the Office of Statewide Health Planning and Development (OSHPD).<sup>9</sup> These data allow the calculation of quarterly observations (for 1996-1998, inclusive) of the average net revenue received per inpatient acute-care admission for privately insured patients and for all patients.<sup>10</sup> As mentioned previously, hospitals provide numerous inpatient services, some of which may or may not be demand- or supply-side substitutes. Regardless, a single measure of inpatient price is consistent with the "cluster" approach used to define hospital product markets in many hospital investigations.<sup>11</sup>

CONTROL VARIABLES - The unit of output used for this work is not a homogeneous good. Patient stays vary substantially in terms of their resource intensity. This heterogeneity must be controlled for in order to lend validity to cross-sectional and intertemporal comparisons of "price". I attempt to add consistency to this measure by using several methods and variables.

---

<sup>9</sup> All of the California data used in this analysis is available for download from [www.oshpd.cahwnet.gov](http://www.oshpd.cahwnet.gov).

<sup>10</sup> Net inpatient price was calculated by multiplying total net revenues from non-Medicare, non-Medicaid patients by the ratio of gross inpatient revenue to gross total revenue at the hospital. While this net figure eliminates Medicare and Medicaid patients it does include revenue from some patients in various non-Medicaid indigent programs. This net revenue figure is then divided by discharges to obtain the average price paid per non-Medicare, non-Medicaid acute-care inpatient. I also adjust the number of discharges by the ratio of (total revenue - bad debt)/total revenue in order to account for bad debt [Vita and Sacher (1999)].

<sup>11</sup> For a critical overview of the "acute care inpatient" product market definition used in hospital merger investigations, see Sacher and Silvia (1998) and Vita and Sacher (1999).

A hospital case mix measure is included which measures resource intensity used on average. This index is calculated in the American Hospital Directory by weighting all diagnosis related groups (DRGs) a hospital performs by a case weight index developed by the Health Care Financing Administration (HCFA) and taking the average for each hospital. A further control for the output heterogeneity is the average length of stay for all patients. The rationale for including this measure is straightforward - each additional day of hospitalization requires the consumption of additional labor and material resources. It is calculated by dividing total patient days by discharges. Also, the average length of stay is a commonly accepted measure of quality. It is typically argued to be a positive representation of quality because of hospitals' efforts to minimize length of stay. Patients perceive an extended length of stay as a sign of quality [Luft et al. (1990)]. The price of discharges across different time periods, or across different hospitals, cannot be accurately compared unless the variations in the length-of-stay enter into the analysis.

Equilibrium hospital prices will also be affected by exogenous changes in the factor prices. I include two variables to control for these effects. First, the HCFA computes a wage index for all urban areas (a county or set of counties) based on the salaries and wages of various health care workers in the relevant locale. California is divided into 14 separate Health Care Statistical Areas (HSAs). See Table 1 for HSA definitions and percentage of different types of hospitals. These numbers represent the percentage of for-profit, nonprofit, and government

**TABLE 1: SHARE OF HOSPITAL TYPE IN EACH HSA AND HSA DEFINITIONS**

<b>HSA</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
% For-profit	17	5	21	0	23	14	19
% Nonprofit	51	86	58	89	46	62	73
% Government	32	9	21	11	31	24	8

<b>HSA</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>
% For-profit	21	9	20	44	25	59	11
% Nonprofit	76	40	67	51	37	41	63
% Government	3	51	13	5	38	0	26

<b>HSA Value</b>	<b>Meaning</b>
1	Northern California HSA
2	Golden Empire HSA
3	North Bay HSA
4	West Bay HSA
5	East Bay HSA
6	North San Joaquin HSA
7	Santa Clara HSA
8	Mid-Coast HSA
9	Central HSA
10	Santa Barbra/Ventura HSA
11	Los Angeles County HSA
12	Inland Counties HSA
13	Orange County HSA
14	San Diego/Imperial HSA

***HSA** - Health Service Area in which the hospital is located This geographic area, consisting of one or more contiguous counties, is designated by the US Department of Health and Human Services for health planning on a regional basis as required by Public Law.*

hospitals within a Health Care Statistical Area (HSA). The HCFA wage index is used to adjust hospital payments under the Prospective Payment System (PPS) for Medicare. The Bureau of Labor Statistics (BLS) Producer Price Index for surgical and medical instruments and apparatus accounts for the second control variable for factor prices. I include several other variables to control for exogenous demand- and supply-side variation. These consist of per capita income, county population density, share of admissions Medicare, and share of Admissions MediCal.<sup>12</sup>

Lastly, I include a Herfindahl index for nonprofit and for-profit hospitals in each Health Care Statistical Area (HSA).<sup>13</sup> Including a Herfindahl index may help isolate competitive behavior between hospitals. Depending upon the results, collusive behavior could be inferred from parameter estimates. Decreasing prices are typically associated with increasing competition, *ceteris paribus*. If hospitals collude on price, the normal competitive forces would be corrupted. I include the two separate indexes to further distinguish the differences between types of control.

QUALITY - I include several variables as a proxy for quality. First, I use the ratio of staffed beds to total beds with the assumption that the higher this ratio, the higher the level of care inpatients receive. Staffed beds represent the number of beds that have full staffing resources available. This argument is similar to the above-mentioned issue of cost cutting. Patients perceive a higher ratio of staffed

---

<sup>12</sup> MediCal is a federally-aided, state operated and administered program which provides medical benefits for certain low-income persons. This is California's version of the federal Medicaid program.

<sup>13</sup> The Herfindahl index is equal to the sum of the squares of market shares for nonprofit and for-profit hospitals. The index is calculated using total discharges (both nonprofit and for-profit) within the HSA.

beds as a more personable level of care and thus, higher quality. Secondly, I include capital expenditures per discharge to capture hospitals' efforts to increase the quality of their capital stock. Medically advanced hospitals continue to expand and improve their medical capital. Thirdly, I include teaching status as a measure of quality. The final measure of quality is the previously discussed average length of stay.

**DUMMY VARIABLES** - Five dummy variables are used in this empirical work to account for other differences across hospitals. A dummy for type of control, equal to one if for-profit or zero otherwise, partly separates the difference in objective functions. There is also a dummy for government-controlled hospitals. This only represents government hospitals that were transitioned to for-profit or nonprofit types of control. Table 1 shows the percentage share of for-profit and government hospitals in each HSA.

Those hospitals affiliated with a major healthcare organization (e.g. Columbia) also are flagged with a dummy variable. Not all hospitals have case mix indexes available for researchers. A simple average is used in place of missing data but a dummy variable depicts all those hospitals not providing this data. The use of this variable should capture any systematic characteristics associated with not providing data. Finally, a dummy variable is included that captures a hospital's teaching status, as mentioned above.



## 5.2 DATA

The data set contains 335 observations on hospitals in California over 12 time periods. The data are quarterly data spanning the beginning of 1996 to the end of 1998, inclusive. Variable definitions and means are listed in Table 2. The mean for type of control (TOC) shows for-profit hospitals account for 33 percent of the observations. Also worth noting, the average total price per discharge (PRTO) is \$5723.84 and the average number of discharges (DIS\_TOT) is 1885. The bulk of the data used in this analysis comes from Office of Statewide Health Planning and Development (OSHPD). Input cost data come from the Bureau of Labor Statistics (BLS) and the Health Care Financing Administration (HCFA). Exogenous demand shifters come from the Bureau of the Census while the case mix index comes from the American Hospital Directory (AHD).<sup>14</sup> The data are divided up into different HSAs (Health Care Statistical Area) computed by the HCFA.

Those hospitals included in this data set fall into the category of short-stay general hospitals with nonprofit or for-profit control structures. Specialty hospitals, psychiatric hospitals, and long-term care hospitals are not included. If the analysis were to focus solely on outpatient procedures, the relevant data set would need to be greatly expanded.

## 5.3 EMPIRICAL RESULTS

The estimated parameters of the empirical model are listed in Tables 3 and 4. Table 3 contains the results for all California hospitals using the Parks method.

---

<sup>14</sup> The American Hospital Directory is a web-based company providing comparative statistics between most U.S. hospitals. Their web address is [www.ahd.com](http://www.ahd.com).

**TABLE 2: DESCRIPTIVE STATISTICS**

<b>Variable name</b>	<b>Description</b>	<b>Mean</b>
DUM_AFF	<i>Dummy variable = 1 if affiliated with major health plan, = 0 otherwise.</i>	0.19
DUM_GOV	<i>Dummy variable = 1 if controlled by government, = 0 otherwise.</i>	0.01
TOC	<i>Dummy variable = 1 if for-profit hospital, = 0 if non-profit or government controlled hospital.</i>	0.33
POPDEN	<i>Population per square mile.</i>	1637.03
INCPC	<i>Income per capita.</i>	16268.35
WAGE	<i>The HCFA wage index for salaries and wages for various health care workers.</i>	118.49
PPI_SUR	<i>Producer Price Index for surgical and medical instruments and apparatus.</i>	129.28
DUM_CASE	<i>Dummy variable = 1 if no case mix is available for the hospital, = 0 otherwise.</i>	0.23
CASEMIX	<i>AHD case mix index measuring the resource intensity used, on average, by hospitals</i>	1.39
LICBED	<i>Number of licensed beds (excluding beds placed in suspense and nursery bassinets).</i>	210.19
CAPDIS	<i>Total quarterly expenditures for additions of property, plant, and equipment/total discharges</i>	685.49
RATSBED	<i>Average compliment of beds fully staffed/licensed beds.</i>	0.83
PRPR	<i>Price per discharge for those privately insured.</i>	5528.16
PRTO	<i>Price per discharge for all patients.</i>	5723.84
DIS_MCAR	<i>Number of formally admitted patients for which Medicare was the primary payer/total discharges</i>	0.3
DIS_MCAL	<i>Number of formally admitted patients for which MediCal was the primary payer/total discharges</i>	0.17

**TABLE 2: DESCRIPTIVE STATISTICS - CONTINUED**

<b>Variable name</b>	<b>Description</b>	<b>Mean</b>
DIS_TOT	<i>Total number of formally admitted patients discharged from the hospital, excluding nursery discharges and including deaths.</i>	1885.47
DAY_TOT	<i>Number of inpatient days of care (census days) provided to all patients / total discharges.</i>	4.92
HI_NON	<i>Herfindahl Index for non-profit hospitals. Calculated quarterly for each HSA</i>	0.04
DUM_TCH	<i>Dummy variable = 1 if positive deductions from gross revenue for teaching expenses, = 0 otherwise.</i>	0.02
HI_FOR	<i>Herfindahl Index for for-profit hospitals. Calculated quarterly for each HSA</i>	0.01

The table includes results from separate estimations that use average net revenue per patient for all patients and for those patients who are privately insured as the dependent variable. Table 4 consists of estimates of quality effects using average length of stay, capital expenditure per discharge, and ratio of staffed beds as dependent variables in separate regressions.

### 5.3.1 PRICE REGRESSIONS

As mentioned previously, the parameter estimates generated by the Fuller method are probably biased. The parameter estimates generated by the Fuller method are listed the Appendix. The following discussion utilizes the results produced by the Parks method as seen in Table 3. Worth consideration, however, is that the magnitude and significance of the coefficients generated by the different methods is not drastic. The following discussion primarily focuses on the signs of the various parameter estimates.

All of these results provide some evidence of differences in pricing behavior and quality provision among the different types of hospitals. Across all hospitals in California the dummy variable for type of control (Table 3, row 4) is positive and significant for the average price for all patients as well as the price for those patients privately insured. This indicates a significantly positive effect on price if the hospital is a for-profit institution. This is consistent with the predictions of the theoretical model.

**TABLE 3: ESTIMATES FOR PRICE EFFECTS: PARKS METHOD**

N = 4020

R<sup>2</sup> = 0.43R<sup>2</sup> = 0.22

Row	Variable	PRICE - TOTAL		PRICE - PRIVATE	
		Coefficient	t-value	Coefficient	t-value
1	INTERCEPT	8053.85	2.81	-5161.28	-1.31
2	DUM_AFF	-2112.39	8.37	-1823.58	-5.89
3	DUM_GOV	-200.26	-1.03	-474.97	-1.82
4	TOC	471.48	2.94	380.75	1.78
5	POP_DEN	-0.07	-1.66	0.01	0.22
6	INC_PC	0.17	4.79	0.15	3.50
7	WAGE	1.21	0.15	2.75	0.27
8	PPI_SUR	-106.29	-4.63	-10.84	-0.34
9	DUM_CASE	-43.21	-0.36	-81.69	-0.48
10	CASEMIX	2926.23	8.76	3426.86	7.74
11	CAP_DIS	0.03	3.09	0.03	1.79
12	RATSBED	1759.08	10.46	1394.31	5.74
13	DIS_MCAR	3638.58	12.47	4699.88	10.86
14	DIS_MCAL	605.26	10.46	3730.28	8.32
15	DAY_TOT	344.98	29.26	239.38	12.89
16	DED_TCH	7981.61	16.89	7305.10	8.97
17	HI_NON	4864.25	2.41	2523.65	1.07
18	HI_FOR	-6965.09	-0.71	13861.42	1.14

DUM_AFF	<i>Dummy variable = 1 if affiliated with major health care plan, = 0 otherwise.</i>
DUM_GOV	<i>Dummy variable = 1 if government hospital, = 0 otherwise.</i>
TOC	<i>Dummy variable = 1 if for-profit hospital, =0 otherwise.</i>
POP_DEN	<i>Population Density</i>
INC_PC	<i>Income per capita</i>
WAGE	<i>Wage index for medical personnel</i>
PPI_SUR	<i>PPI for medical and surgical apparatus</i>
DUM_CASE	<i>Dummy variable = 1 if hospital does not provide case mix, = 0 otherwise.</i>
CASEMIX	<i>Case mix index</i>
CAP_DIS	<i>Capital expenditures per discharge</i>
RATSBED	<i>Ratio of staffed beds</i>
DIS_MCAR	<i>Ratio of Medicare discharges</i>
DIS_MCAL	<i>Ratio of MediCal discharges</i>
DAY_TOT	<i>Average Length of Stay</i>
DED_TCH	<i>Dummy variable = 1 if positive expenditures on teaching, = 0 otherwise.</i>
HI_NON	<i>Herfindahl index for nonprofits within a HSA</i>
HI_FOR	<i>Herfindahl index for for-profits within a HSA</i>

The price effect is over 20 percent higher to those patients who are insured by private companies. This could be explained by these patients' susceptibility to price discrimination. Nonprofit hospitals may find it most rewarding to use this group of patients as a source of additional funding for other continued and expanded operation. As a result, the difference between for-profit and nonprofit pricing becomes less pronounced when this group of patients are the dependent variable. That is, nonprofits behave more as profit-maximizers when providing health services for these patients.

Also worth noting is that those hospitals affiliated with a large health organization have significantly negative estimates (Table 3, row 2). This may be an interesting example of economies of scale and/or scope that is worth further empirical study. Affiliation with a large health organization may make accessing skilled professional services and medical facilities less expensive. These hospitals may operate more efficiently because of the wide range of resources available to them and the learning by doing effect inherent in an extended facility.

The other consistently statistically significant coefficients of interest for California wide hospitals prove to be rather interesting as well. The coefficient for the price of surgical apparatuses (Table 3, row 8) is only significant when total price is the dependent variable and it is always negative. This goes against the expected positive sign. Perhaps hospitals move towards less intensive techniques in the face of rising input costs. The savings they incur are passed on to the consumer. In the case of nonprofits, utility would increase in quantity but would

fall in quality (assuming a certain level of surgical apparatus affects quality). As the price of inputs increase, the quality-quantity tradeoff shifts inward and the hospital strives to maximize utility given a new frontier.

The coefficients on the demand shifters of per capita income (Table 3, row 6), the ratio of Medicare patients to total patients (Table 3, row 13), and the ratio of MediCal patients to total patients (Table 3, row 14) are always positive, as intuition predicts. The parameter estimate for the ratio of MediCal patients, however, is over 400 percent higher for price incurred by those who are privately insured as opposed to the price effect for total patients. As this ratio increases, more hospital resources are being used under a structured reimbursement program, which is typically the least profitable. Therefore, as this ratio increases, more profits are recouped from the privately insured. Perhaps this is further evidence that those privately insured or uninsured patients are the source of higher profits. This is consistent with the theory of price discrimination.

The coefficient for the case mix index (Table 3, row 10) is positive and significant supporting the notion that price will rise as more complicated and resource intensive procedures are performed. This helps control for the heterogeneity of output inherent in studying the health care market. There is no evidence that those hospitals not providing case mix data have systematically different price effects.

The Herfindahl index only proves to be significant for nonprofit hospitals (Table 3, row 17) and a positive sign is associated with the coefficient. If a

nonprofit hospital (or hospitals) becomes more dominant in a market, it may find it consistent with its objectives to price as joint profit-maximizers and in turn, use this profit to enhance quality. Raising price has several effects for a given hospital. Raising own price has no effect because they are starting at the non-cooperative equilibrium but increases in rivals' price has a positive effect on said hospital's quantity and profit. This outcome on price is consistent with the predictions of the collusive theoretical model. The destination of higher profits (assuming price increases are undertaken to increase profit) is unclear. Data from the quality effects regressions do not support the explanation of increased quality, as is discussed momentarily.

Quality indicators consistently prove to have a positive effect on both measures of price. Increasing the quality of care through increasing the capital expenditures per discharge (Table 3, row 11), the ratio of staffed beds (Table 4, row 12), and the average length of stay (Table 3, row 15), as well as being affiliated as a teaching hospital (Table 3, row 16) appear to be positively correlated with price and thus, financed by the consumer. The inclusion of Herfindahl indexes in the quality equation sheds more light onto this discussion.

### 5.3.2 QUALITY REGRESSIONS

The results for the quality regressions are shown in Table 4. For average length of stay (DAYTOT) and ratio of staffed beds (RATSBED) the parameter estimate is significantly negative for the nonprofit Herfindahl index (Table 4, rows



**TABLE 4: ESTIMATES OF THE QUALITY EFFECTS: FULLER METHOD**

**\*Dependent Variable = DAYTOT**  $R^2 = 0.11$

<i>Row</i>	<i>Variable</i>	<i>Coefficient</i>	<i>t-value</i>
1	INTERCEPT	3.62	12.58
2	TOC	-0.3	-1.39
3	<i>One-period lag of Total Price</i>	0.01	14.7
4	<i>Two-period lag of Total Price</i>	< 0.01	1.02
5	HI_NON	-15.14	-3.44
6	HI_FOR	-6.31	-0.43

**\*Dependent Variable = CAPDIS**  $R^2 = 0.10$

<i>Row</i>	<i>Variable</i>	<i>Coefficient</i>	<i>t-value</i>
7	INTERCEPT	556.9	4.5
8	TOC	-367.84	-3.95
9	<i>One-period lag of Total Price</i>	0.01	0.39
10	<i>Two-period lag of Total Price</i>	0.01	0.39
11	HI_NON	2064.85	1.18
12	HI_FOR	13273.59	1.94

**\*Dependent Variable = RATSBED**  $R^2 = 0.09$

<i>Row</i>	<i>Variable</i>	<i>Coefficient</i>	<i>t-value</i>
13	INTERCEPT	0.71	23.45
14	TOC	-0.11	-4.97
15	<i>One-period lag of Total Price</i>	< 0.01	13.03
16	<i>Two-period lag of Total Price</i>	< 0.01	1.82
17	HI_NON	-0.86	-1.84
18	HI_FOR	0.59	0.41

TOC *Dummy variable = 1 if for-profit hospital, =0 otherwise.*  
 CAP\_DIS *Capital expenditures per discharge*  
 RATSBED *Ratio of staffed beds*  
 DAY\_TOT *Average Length of Stay*  
 HI\_NON *Herfindahl index for nonprofits within a HSA*  
 HI\_FOR *Herfindahl index for for-profits within a HSA*

5 and 17, respectively). While price is rising as nonprofits gain more market share, it does not appear to increase quality, at least in terms of these measures. This is still consistent with theory, which does not unambiguously predict higher or lower quality with collusion. There are two effects counteracting each other. As the rivals' quality increases, a given hospital loses quantity and in turn, indirectly decreases utility. Utility increases directly, however, as the hospital's own quality increases.

Two scenarios may explain the prevailing situation. First, quality competition does indeed exist between nonprofit hospitals. Quality becomes more strategic as nonprofits divide up market shares or nonprofits lose market share to for-profit hospitals. In this case, quality increases as competition increases. This suggests hospitals embrace quality more as a tool for increasing demand than increasing prestige directly. That is, prestige is useful in attracting patients rather than directly benefiting the decision-maker.

Secondly, quality increases as a result of higher profits but it takes other forms. For instance, a nonprofit hospital may have previously built up their capital stock and use high profits to finance its maintenance. This would not show up in current capital expenditures. Also, the monies may be used to retain highly skilled physicians or researchers. While quality does not appear to be increasing in the examined variables, it cannot be concluded that quality per se does not increase unless a more exhaustive accounting of quality is included in the empirical work.

The Herfindahl index for for-profit hospitals is positive and significant for capital expenditures per discharge (CAPDIS). This is seen in Table 4, row 12. As seen in Table 1, for-profit hospitals do not typically account for the majority of hospitals. The maximum percentage of for-profits is 59 percent (HSA 13) but for the remaining areas, for-profits never account for more than 44 percent.

First, it is paramount to understand that for-profit hospitals typically engage in the most profitable procedures of health care. These are typically low-end, common procedures. As for-profits try to capture a larger share of the market, they must provide a wider range of services. By doing this, they will compete against the nonprofit hospitals more directly. In turn, they will have to spend more money to provide these services as well as provide a competitive level of quality. Thus, as for-profits gain more market share, they will provide a higher level of capital expenditures per discharge in order to compete with nonprofit hospitals.

Finally, the dummy variable for type of control in the quality equation is consistently significant (at the ten percent level for average length of stay) and more importantly, is consistently negative (Table 5, rows 2, 8, and 14). If a hospital is for-profit ( $TOC = 1$ ), then it provides a lower level of quality across the board. This is the case when considering quality as represented by the three proxies used in this empirical study. As seen above, if a hospital is nonprofit there is a negative effect on price and, as seen here, there is a positive effect on quality. The nonprofit form embraces quality and quantity in its objective functions and as a result, provides relatively high quality at relatively low cost.

## 6.0 CONCLUSION

Nonprofit hospitals' zero-profit constraint fetters the flow of profits outside of the system but promotes quality advancements within the hospital. The quality patients receive comes at a high financial cost. While the government does favor nonprofit hospitals, subsidies and grants are not enough to finance hospitals' optimal levels of quality. Consumers (or their insurance companies) pay a substantial portion of the health care cost. The quality received at nonprofit hospitals is significantly greater than at for-profit hospitals. Also, the price paid at nonprofit hospitals is significantly lower than at for-profit hospitals. Thus, the quality received at nonprofit hospitals is partly financed through the revenue taken in from consumers and is also partly financed by the government or other third parties.

Theoretically, nonprofit hospitals provide a higher level of quality and charge a lower price than their for-profit counterparts. This theoretical prediction is empirically supported in this work. The reason for the difference comes from the nonprofit's zero profit constraint and the differences in objective functions. The nonprofit firm derives satisfaction through quantity as well as quality while the for-profit firm primarily strives to maximize profit.

The interaction between the two types of hospitals demonstrates the dynamic nature of competition between firms. There is evidence that nonprofits do exercise increased market power as the market becomes more concentrated with

nonprofit hospitals. This could be because it is easier to sustain a collusive outcome with less players. It is not clear, however, how these higher profits are dissipated. Legally, they cannot be dispersed to managers but there is no evidence they enhance quality. The evidence suggests a fall in quality which in turn supports the notion of increased quality competition as markets become less concentrated.

The data supports the idea of for-profits increasing quality in order to compete against nonprofit hospitals. Quality becomes a strategic variable for hospitals when making decisions. The results herein support the theoretical predictions of hospitals' level of quality and price. Type of control does directly affect the quality of care received by consumers as well as the price for said care. Also, the nonprofit form does not protect consumers from the exercise of market power.

## BIBLIOGRAPHY

- Arrow, Kenneth J. "Uncertainty and the Welfare Economics of Medical Care." *American Economic Review* 53.5 (1963): 941-973.
- Barton, David and Roger Sherman, "The Price and Profit Effects of Horizontal Merger: A Case Study." *Journal of Industrial Economics* 33.2 (1984): 165-177.
- Brennan, Troyen A., L. Leape, N. Laird, L. Hebert, A. Localio, A. Lawthers, J. Newhouse, P. Weiler, H. Hiatt. "Incidence of Adverse Events and Negligence in Hospital Patients." *New England Journal of Medicine* 324.6 (1991): 370-376.
- Davis, Mark A. "On Nursing Home Quality: A Review and Analysis." *Medical Care Review* 48 (1971): 129-166.
- Dranove, David and Richard Ludwick. "Competition and Pricing by Nonprofit Hospitals: A Reassessment of Lynk's Analysis." *Journal of Health Economics* 18.1 (1999): 87-98.
- Gaumer, Gary L. "Regulating Health Professionals: A Review of Empirical Literature." *Milbank Memorial Fund Quarterly/Health and Society* 62 (1984): 380-416.
- Greene, William H. *Econometric Analysis: Third Edition*. Upper Saddle River: Prentice Hall, 1997
- Eckel, Catherine C. and Richard Steinberg. "Competition, Performance, and Public Policy toward Nonprofits," *Nonprofit Organizations in a Market Economy*. Eds. David C. Hammack and David R. Young. San Francisco, CA: Jossey-Bass Publishers, 1993.
- Feldstein, Paul J. *Health Care Economics: Fifth Edition*. Albany: Delmar Publishers, 1999.
- Folland, Sherman, Allen C. Goodman, and Miron Stano. *The Economics of Health and Health Care*. Upper Saddle River: Prentice Hall, 1997.

- Gasmi, F., J.J. Laffont, and Q. Vuong. "Econometric Analysis of Collusive Behavior in a Soft-Drink Market." *Journal of Economics & Management Strategy* 1.2 (1992): 277-311.
- Gibbons, Robert. *Game Theory for Applied Economists*. Princeton: Princeton University Press, 1992.
- Hansmann, Henry B. "The Role of Non-Profit Enterprise." *Yale Law Journal* 89 (1980): 835-901.
- Harris, Jeffery E. "The Internal Organization of Hospitals: Some Economic Implications." *Bell Journal of Economics* 8.2 (1977): 467-482.
- Haas-Wilson, Deborah. "Consumer Information and Provider Reputation: An Empirical Test in the Market for Psychotherapy." *Journal of Health Economics* 9.3 (1990): 321-333.
- Held, Philip and Mark Pauly. "Competition and Efficiency in the End Stage Renal Disease Program." *Journal of Health Economics* 2.2 (1983): 95-118.
- Henderson, James W. *Health Economics and Policy*. Cincinnati: South-Western College Publishing, 1999.
- Hirth, Richard A. "Consumer Information and Competition between Nonprofit and For-Profit Nursing Homes." *Journal of Health Economics*. 18.2 (1999): 219-240.
- James, Estelle. "How Nonprofits Grow: A Model." *Journal of Policy Analysis and Management*. 2.3 (1983): 350-366.
- James, Estelle and Susan Rose-Ackerman. "The Nonprofit Enterprise in Market Economics." *Fundamentals of Pure and Applied Economics*. Eds. J.M. Montias and J. Kornai. New York, New York: Harword Academic Publishers, 1986.
- Kadiyali, Vrinda. "Entry, its Deterrence, and its Accommodation: A Study of the U.S. Photographic Film Industry." *RAND Journal of Economics* 27.3 (1996) 452-478.
- Kennedy, Peter. *A Guide to Econometrics: Fourth Edition*. Cambridge: MIT Press, 1998.
- Lee, Maw L. "A Conspicuous Production Theory of Hospital Behavior." *Southern Economic Journal* 38.1 (1971): 48-58.

- Luft, Harrold S., James C. Robinson, Deborah Garnick, Susan C. Maerki, and Stephen J. McPhee. "The Role of Specialized Clinical Services in Competition among Hospitals." *Inquiry* 23.1 (1986): 83-94.
- Luft, Harold S., D. W. Garnick, D. H. Mark, D. J. Peltzman, C. S. Phibbs, E. Lichtenberg, S. J. McPhee. "Does Quality Influence Choice of Hospitals?" *Journal of the American Medical Association* 263.21 (1990): 2899-2906.
- Lynk, William J. "Nonprofit Hospital Mergers and the Exercise of Market Power." *Journal of Law and Economics* 38.2 (1995): 431-461.
- Newhouse, Joseph P. "Toward a Theory of Nonprofit Institutions: An Economic Model of a Hospital." *American Economic Review* 60.1 (1970): 64-73.
- Netz, Janet S. "Nonprofits and Price Fixing: The Case of the Ivy League." Work in Progress, Purdue University. December 1998.
- Noether, Monica. "Competition among Hospitals," *Journal of Health Economics* 7.3 (1988): 259-284.
- Pauly, Mark V. "Nonprofit Firms in Medical Markets." *American Economic Review* 77.2 (1987): 257-262.
- Pauly, Mark and Michael Redisch. "The Not-For-Profit Hospital as a Physicians' Cooperative." *The American Economic Review* 63.1 (1973): 87-99.
- Robinson, James C. and Harold S. Luft. "The Impact of Hospital Market Structure on Patient Volume, Average Length of Stay and the Cost of Care." *Journal of Health Economics* 4.4 (1985): 333-356.
- - -. "Competition and the Cost of Hospital Care, 1972 to 1982." *Journal of the American Medical Association* 257.23 (1987): 3241-3245.
- Robinson, James C., Stephan J. McPhee, and Sandra S. Hunt. "Hospital Competition and Surgical Length of Stay." *Journal of the American Medical Association* 259.5 (1988): 696-700.
- Sacher, Seth and Louis Silvia. "Antitrust Issues in Defining the Product Market for Hospital Services." *International Journal of the Economics of Business* 5.2 (1998): 181-202.



- SAS Institute. *SAS/ETS® User's Guide, Version 6: Second Edition*. Cary, North Carolina, 1993.
- Schiff, Jerald and Burton Weisbrod. "Competition between For-profit and Nonprofit Organizations in Commercial Markets." *The Nonprofit Sector in the Mixed Economy*. Eds. Ben-Ner, Avner, Gui, Benedetto. Anne Arbor, MI: University of Michigan Press, 1993.
- Schumann et al. "Case Studies of the Price Effects of Horizontal Mergers." *Bureau of Economics Staff Report*. Washington, DC: Federal Trade Commission, 1992.
- Tirole, Jean. *The Theory of Industrial Organization*. Cambridge: MIT Press, 1998.
- Vita, Michael G. and Seth Sacher. "The Competitive Effects of Not-For-Profit Hospital Mergers: A Case Study." *Bureau of Economics, Federal Trade Commission Working Papers No. 226*. Washington, DC: Federal Trade Commission, May 1999.
- Weisbrod, Burton. "Rewarding Performance that is hard to Measure: The Private Non-Profit Sector." *Science* 244.4904 (1989): 541-546.

## APPENDIX

## APPENDIX

TABLE A1: ESTIMATES FOR PRICE EFFECTS: FULLER METHOD

		R <sup>2</sup> = 0.53		R <sup>2</sup> = 0.26	
		PRICE - TOTAL		PRICE - PRIVATE	
Row	Variable	Coefficient	t-value	Coefficient	t-value
1	INTERCEPT	8453.53	4.6	-309.43	-0.09
2	DUM_AFF	-2255.02	-8.43	-1705.35	-5.18
3	DUM_GOV	45.47	0.22	-237.68	-0.62
4	TOC	422.63	3.13	213.91	1.01
5	POP_DEN	-0.02	-0.39	0.02	0.37
6	INC_PC	0.1	2.59	0.08	1.66
7	WAGE	-4.27	-0.62	11.97	-1.15
8	PPI_SUR	-78.05	-5.06	14.8	-0.54
9	DUM_CASE	-84.08	-0.82	144.64	0.8
10	CASEMIX	1387.67	5.42	2155.28	4.94
11	CAP_DIS	0.04	3.04	0.05	2.08
12	RATSBED	1698.48	11.75	1327.85	5.13
13	DIS_MCAR	3954.66	14.66	4609.63	9.59
14	DIS_MCAL	-1139.34	-3.87	3226.92	6.34
15	DAY_TOT	414.9	31.26	349.56	14.46
16	DED_TCH	8235.87	15.25	7289.65	9.06
17	HI_NON	3018.51	1.62	2291.85	0.72
18	HI_FOR	-10211.6	-1.06	11658.65	0.75

DUM_AFF	Dummy variable = 1 if affiliated with major health care plan, = 0 otherwise.
DUM_GOV	Dummy variable = 1 if government hospital, = 0 otherwise.
TOC	Dummy variable = 1 if for-profit hospital, = 0 otherwise.
POP_DEN	Population Density
INC_PC	Income per capita
WAGE	Wage index for medical personnel
PPI_SUR	PPI for medical and surgical apparatus
DUM_CASE	Dummy variable = 1 if hospital does not provide case mix, = 0 otherwise.
CASEMIX	Case mix index
CAP_DIS	Capital expenditures per discharge
RATSBED	Ratio of staffed beds
DIS_MCAR	Ratio of Medicare discharges
DIS_MCAL	Ratio of MediCal discharges
DAY_TOT	Average Length of Stay
DED_TCH	Dummy variable = 1 if positive expenditures on teaching, = 0 otherwise.
HI_NON	Herfindahl index for nonprofits within a HSA
HI_FOR	Herfindahl index for for-profits within a HSA