

The Objective Function Matters: An Investigation of Competition in the Hospital Industry

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Abstract

In this paper, we use three simple theoretical models of nonprofit hospitals to investigate equilibrium behavior when hospitals compete and merge. We examine how prices, quantity of patients served, and quality of care are affected as nonprofits place more weight on profit maximization. We find that the specification of the nonprofit motive influences the results. When nonprofit hospitals care about serving the uninsured, prices fall as the market becomes more competitive. However, when hospitals compete on price and quality and the nonprofit motive is quality maximization, prices and quality rise as the nonprofit cares more about profit maximization. In addition and contrary to popular belief, the presence of a nonprofit motive does not preclude competitive behavior when a merger occurs. When a nonprofit acquires a for-profit hospital, we find that even if the nonprofit is pursuing objectives other than profit maximization, prices for the acquiring hospital unambiguously rise after a merger. We also find that, due to nonprice competition, quality of care decreases for the nonprofit hospital if a merger occurs.

1 Introduction

An extensive literature exists concerning competition between for-profit firms. From Cournot to Bertrand models, with homogeneous or differentiated products, the economic theory of profit-maximizing organizations is well understood. However, industries, such as the hospital industry, where nonprofit firms dominate have received little attention. As suggested by studies such as Newhouse (1970), Pauly and Redisch (1973), and Dusansky and Kalman (1974), nonprofits may have a different objective than profit maximization. Their reaction to a competitive environment might not follow the conventional predictions for competitive behavior. Given the public policy concerns about rising health care costs and availability of services, better understanding of the effects of competition when nonprofits are present in the market is essential.

Relatively recent changes to this industry have forced nonprofits to become more competitive. The presence of managed care plans and the shift to the Prospective Payment System by Medicare in 1983 created greater incentives to reduce costs. Presumably, the wave of hospital mergers and acquisitions in the 1990's was largely a response to these changes. Although more media attention has focused on acquisitions of nonprofit hospitals by for-profit health care systems, individual hospitals, as well as nonprofit health care systems, have also engaged in merger activity.

Although several empirical studies investigate the effects of consolidations and for-profit conversions on prices, outputs, and efficiency, results from these studies are contradictory, and thus, inconclusive. In particular, there is debate in the literature concerning whether nonprofits raise prices in response to a merger. Given that non-

profits may not profit maximize, a broader theoretical perspective of competition in the industry may provide insight into this debate.

This paper uses a simple theoretical model to explore competition in the hospital industry and to study how different nonprofit objective functions influence equilibrium behavior. In particular, we construct three separate models with different nonprofit objective functions to investigate how prices, output, and quality of service change when i) a nonprofit and for-profit compete, ii) two nonprofits compete, iii) a nonprofit hospital merges into a for-profit hospital, and iv) a for-profit merges into a nonprofit hospital.

The next section of the paper discusses previous models of nonprofit behavior and previous literature on price increases when nonprofits merge. Section 3 presents in detail the three models of competition used in this paper. Section 4 discusses the equilibrium results when a nonprofit competes with either a for-profit firm or another nonprofit hospital. The changes to equilibrium behavior when a merger occurs are presented in Section 5 and the final section concludes the paper.

2 Previous Literature

One of the first theories of nonprofit objectives comes from Long (1964). He suggested that hospitals seek to maximize the number of patients served subject to budget and quality constraints. Newhouse (1970) builds on this model to explicitly incorporate quality into the objective function. He conjectures that nonprofit hospitals jointly maximize quality and quantity subject to a budget constraint. For each level of qual-

ity, the hospital chooses the maximum quantity possible given a zero-profit condition. The hospital then chooses the quantity-quality combination that produces the highest attainable level of utility for the hospital. Although this model still leads to production of the least costly bundle, the emphasis on quality implies an inefficient mix of services. In particular, nonprofits are biased toward providing higher quality services than for-profit hospitals.

Instead of corporate ownership, nonprofit hospitals may be owned by a group of community physicians. Although less prevalent in today's industry, Pauly and Redisch (1973) investigate the behavior of these physician cooperatives. They assume that staff physicians have de facto control of the hospital and operate the hospital in order to maximize the sum of income for all physicians. In the short-run, they show that, if the number of physicians is fixed, the model is identical to that of a profit-maximizing hospital with one input fixed. However, the long-run behavior depends on the hospital's staffing policy. If the entry of new physicians must be approved by the cooperative (closed staffing policy) and hospital revenue are divided equally among the physicians, then an increase in demand for hospital output leads to higher prices (i.e., upward sloping demand curve), lower outputs, and fewer physicians. If entry into the cooperative is open, the equilibrium number of physicians is greater than in the closed staffing policy, although the hospital still may not employ the optimal number of physicians. All of these results assume cooperative behavior between the physicians. Noncooperative behavior between the physicians leads to overutilization of labor relative to the cooperative solution.

Teaching hospitals presumably have different objectives due to their educational

mission. Dusansky and Kalman (1974) address this different objective in their model. In their paper, hospitals are concerned with the diversity of the medical cases. Patients are classified based on their teaching usefulness classification (TUC). In order to adequately train medical students, the hospital needs a certain number of patients for each TUC. The hospital, therefore, minimizes costs subject to meeting this lower bound for every TUC.

Lynk (1995b) relies on the assumption of a nonprofit motive to argue that mergers by nonprofits do not raise prices in the market. He assumes that nonprofit hospitals function similarly to a consumer cooperative rather than a profit-maximizing firm, and thus their response to increased market share will not be the same as profit-maximizing firms. He uses a hedonic regression model to regress price per inpatient-day on various structural and demographic characteristics of California hospitals, sub-dividing the price variable by the type of services received. His results suggest that prices decline following a merger of two nonprofit hospitals.

Several papers contradict the findings of Lynk (1995b). Dranove and Ludwick (1999) argue that Lynk's results are biased for several reasons including endogeneity of his market share regressor. After correcting for these biases, Dranove and Ludwick are unable to support lower prices by nonprofit hospitals. Keeler *et al.* (1999) use similar econometric methods to predict changes in hospital service prices after hypothetical mergers in 1986, 1989, 1992, and 1994. They find that all hospitals raise their prices in response to a merger but for-profits have higher price increases than nonprofit hospitals. In addition, mergers between direct competitors not only raise the merging hospitals' prices, but also prices for the remaining hospitals in that market.

Although the most recent empirical evidence described above does indicate that nonprofits respond similarly to their for-profit competitors,¹ it is still commonly thought that nonprofit hospitals behave differently from their for-profit counterparts. As Blackstone and Fuhr (1993) discuss in their paper, even the courts assume that nonprofits have altruistic motives that prevent anticompetitive behavior, and thus, antitrust cases against nonprofit hospital mergers have been mostly unsuccessful. Gaynor and Vogt (2000) using a model where hospitals' residual demand is a function of the firm's output and amenities, and competitors' output and amenities, they show that for-profit and nonprofit hospitals react similarly to a merger. As we describe in detail below, we strengthen this result by showing that the presence of altruistic motives does not necessarily preclude conventional responses to decreased competition. The following section, therefore, develops the models in order to provide a theoretical framework for investigating nonprofit hospital behavior.

3 Theoretical Models

In this paper, we modify the simple Bertrand model to examine equilibrium behavior between a nonprofit and for-profit hospital. Let a market exist with a nonprofit and for-profit hospital, where the hospitals compete on price.² The for-profit hospital

¹For discussion of the effects, other than price changes, of mergers and acquisitions and for-profit conversions see Cutler and Horwitz (2000), Alexander *et al.* (1996), and Lynk (1995a).

²Some might argue that, due to third-party payers in the health care system, patients are not price sensitive, and thus, hospitals do not compete on price. Although it is true that the consumers do not pay full price for hospital services, the insurance companies have contracted with the hospital to provide the services for agreed upon prices. Thus, hospitals still compete on price in order to contract with the insurance companies. In fact, as Dranove and Satterthwaite (2000) note, "they (PPO's and HMO's) are also more capable shoppers than are patients, for they shop on behalf of potentially thousands of patients and can therefore afford to purchase information systems that permit comparison of complex cost and quality information." We, therefore, assert that price

maximizes profits while the nonprofit hospital maximizes a linear combination of profits and a nonprofit motive. Mathematically,

Firm 1 (For-Profit) Objective Function:

$$\max_{p_1} p_1 q_1(p_1, p_2) - c(q_1(p_1, p_2)) \quad (1)$$

Firm 2 (Nonprofit) Objective Function:

$$\max_{p_2} \alpha [p_2 q_2(p_1, p_2) - c(q_2(p_1, p_2))] + (1 - \alpha)V \quad (2)$$

where p_i and q_i are the price and quantity for firm i respectively, $c(\cdot)$ is the cost function, α is the weight assigned to profit maximization, and V is the nonprofit motive to be defined for each of the three models. Depending on V , the nonprofit hospital may choose another variable in addition to p_2 .

Modeling the nonprofit objective function as a linear combination of different objectives is not new to the literature. Steinberg (1986) uses this technique to empirically test whether nonprofit firms are budget or service maximizers. In his paper, he focuses on the nonprofit sector as a whole and uses charitable donations as the main source of revenue for the nonprofit firms. He then estimates α (actually, in his paper, he defines the variable k as the weighting parameter, but for simplicity, we will use α). Although the model in equation (2) could be empirically tested to estimate α , here we assume that α is fixed. The choice of α and the empirical estimation of the parameter are left for further research.

We now need to specify V . Given the different objective functions hypothesized for the nonprofit hospital, we specify three models of nonprofit behavior. We, therefore, competition is a reasonable assumption.

in this paper are not presuming to know the “right” model of nonprofit behavior. In fact, it may be reasonable to assume that no one model of nonprofit hospital behavior is correct. Factors such as the demographics of the population, the location of the hospital in a rural or urban area, and the teaching status of the hospital are likely to influence the objective function of the hospital. We instead want to investigate how equilibrium behavior changes depending on the specified nonprofit objective function.

3.1 Maximize Total Number of Patients Served

As discussed by Long (1964), hospitals may seek to serve the maximum number of patients possible. Thus, the model is:

Firm 1 Objective Function:

$$\max_{p_1} p_1 q_1(p_1, p_2) - c(q_1(p_1, p_2)) \quad (3)$$

Firm 2 Objective Function:

$$\max_{p_2} \alpha [p_2 q_2(p_1, p_2) - c(q_2(p_1, p_2))] + (1 - \alpha) q_2(p_1, p_2) \quad (4)$$

where q_2 , the quantity for the nonprofit hospital, is the nonprofit motive of the hospital. Note that a zero-profit constraint as discussed by Long is implicitly incorporated into this model; there is an α at which the hospital just breaks even.

3.2 Maximize Total Number of Uninsured Patients Served

Conventional wisdom about nonprofit and, in particular religiously affiliated, hospitals is that they are concerned about the health of the entire community, including the economically disadvantaged. We model this sector of the population by assuming that

the indigent have no insurance. The community is then divided between two types: insured and uninsured patients. Uninsured patients are only served by the nonprofit hospital. The nonprofit hospital does not expect to recover the cost of serving these patients. These patients are a function of costs, but they do not provide a form of revenue. Let q_2^1 represent the insured patients while q_2^2 are the uninsured patients. Thus, we get:

Firm 1 Objective Function:

$$\max_{p_1} p_1 q_1(p_1, p_2) - c(q_1(\cdot)) \quad (5)$$

Firm 2 Objective Function:

$$\max_{p_2, q_2^2} \alpha [p_2 q_2^1(p_1, p_2) - c(q_2^1(p_1, p_2), q_2^2)] + (1 - \alpha) q_2^2 \quad (6)$$

The nonprofit hospital chooses prices and also the quantity of uninsured patients served. Since it is assumed that the uninsured cannot pay for their services, the uninsured are not concerned about the price of the services, and therefore, their demand is not a function of price.

3.3 Hospitals Compete on Price and Quality; Nonprofits Maximize Quality

For health care, consumers value the quality of care. Drawing from Newhouse (1970), we let quality of care enter the objective function. In particular, firms compete on price and quality of care. We follow the specification discussed by Dranove and Satterthwaite (2000) in which the quality of care provided by firm i , x_i , enters the objective function indirectly through its effect on quantity. In addition, the nonprofit

hospital cares directly about the quality of its services. We, therefore, get the following model:

Firm 1 Objective Function:

$$\max_{p_1, x_1} p_1 q_1(p_1, p_2, x_1, x_2) - c(q_1(p_1, p_2, x_1, x_2)) \quad (7)$$

Firm 2 Objective Function:

$$\max_{p_2, x_2} \alpha [p_2 q_2(p_1, p_2, x_1, x_2) - c(q_2(p_1, p_2, x_1, x_2))] + (1 - \alpha)x_2 \quad (8)$$

Each hospital chooses its own prices and quality of care. The assumptions about the behavior of the demand function with respect to quality are discussed in the next section.

Henceforth, these models are referred to as models 1, 2, and 3 respectively. Equations (3) through (8) are maximized for each of the choice variables. We then perform comparative statics to determine how the equilibrium behavior for each variable changes as the nonprofit hospital increases its weight on profit maximization (i.e., α increases). An increase in α can be viewed as a need for the nonprofit to become more competitive which, as discussed earlier, seems to be a trend in the industry. The following section presents the first-order conditions and the comparative static results.

In addition to nonprofit and for-profit competition, many markets exist where nonprofit hospitals compete with each other. To model such a market, firm 1 in each model is transformed into a nonprofit hospital that is identical to the other nonprofit hospital in the market. We define these equations as:

$$\max_{p_1} \alpha [p_1 q_1(p_1, p_2) - c(q_1(p_1, p_2))] + (1 - \alpha)q_1(p_1, p_2) \quad (3.3a)$$

$$\max_{p_1} \quad \alpha [p_1 q_1^1(p_1, p_2) - c(q_1^1(p_1, p_2), q_1^2)] + (1 - \alpha)q_1^2 \quad (3.5a)$$

$$\max_{p_1, x_1} \quad \alpha [p_1 q_1(p_1, p_2, x_1, x_2) - c(q_1(p_1, p_2, x_1, x_2))] + (1 - \alpha)x_1 \quad (3.7a)$$

where q_1^1 and q_1^2 are the quantity of insured and uninsured patients served by firm 1. Equations (3.3a), (3.5a), and (3.7a) replace (3), (5), and (7) respectively and the equations are once again maximized and comparative statics analyzed. A comparison of these results and the previous results when a nonprofit and for-profit compete gives a better understanding of whether, qualitatively, the presence of a for-profit in the market affects the equilibrium conditions. Section 4 also presents these comparative static results of competition between two nonprofits and discusses the differences between the two markets.

Another trend in healthcare is the recent wave of mergers, acquisitions, and for-profit conversions. A popular misconception is that all acquisitions result in a for-profit hospital or health care system acquiring a nonprofit hospital. Although this activity is prevalent (Phillips, 1999), an investigation of only for-profit conversions omits many of the dramatic changes to the hospital industry. Nonprofit health care systems, particularly religiously affiliated health care systems, have also engaged in many acquisitions. In several instances, these acquisitions have resulted in a for-profit conversion to a nonprofit hospital.³ It is therefore important to study for-profit and nonprofit acquisitions to better understand the effect on hospital behavior. Section 5 examines how behavior changes when a merger occurs and whether these changes are influenced by the ownership status of the acquiring hospital. Equilibrium conditions

³For examples of such acquisitions, see Irving Levin Associates (2000)

for an acquisition by a nonprofit and also by a for-profit hospital are compared to the pre-merger equilibria and the differences discussed.

4 Results

4.1 Model 1

The first-order conditions for equations (3) and (4) are:

$$\frac{\partial \pi_1}{\partial p_1} = \left(p_1 - \frac{\partial c}{\partial q_1} \right) \frac{\partial q_1}{\partial p_1} + q_1 = 0 \quad (9)$$

$$\frac{\partial \pi_2}{\partial p_2} = \alpha \left[\left(p_2 - \frac{\partial c}{\partial q_2} \right) \frac{\partial q_2}{\partial p_2} + q_2 \right] + (1 - \alpha) \frac{\partial q_2}{\partial p_2} = 0. \quad (10)$$

Due to the nonprofit motive of the nonprofit hospital, the marginal benefit to serving an additional patient is higher than for the for-profit firm. Thus, firm 2 chooses lower prices in order to serve a higher quantity of patients. In order to sign the effect of an increase in α on p_1 and p_2 , we assume that the demand and cost curves are well-behaved. We also assume that demand is linear and that own-price effects are greater than cross-firm price effects. Mathematically:

$$\frac{\partial q_i}{\partial p_i} \equiv q'_i(p_i) < 0 \quad \forall i = 1, 2 \quad (11)$$

$$\frac{\partial q_i}{\partial p_j} \equiv q'_i(p_j) > 0 \quad \forall i \neq j \quad (12)$$

$$\frac{\partial^2 q_i}{\partial p_i^2} = 0 \quad \forall i = 1, 2 \quad (13)$$

$$\frac{\partial^2 q_i}{\partial p_i \partial p_j} = 0 \quad \forall i \neq j \quad (14)$$

$$\left| \frac{\partial q_i}{\partial p_i} \right| > \frac{\partial q_i}{\partial p_j} \quad \forall i \neq j \quad (15)$$

$$\frac{\partial c}{\partial q_i} > 0 \quad \forall i = 1, 2 \quad (16)$$

$$\frac{\partial^2 c}{\partial q_i^2} > 0 \quad \forall i = 1, 2. \quad (17)$$

Given these assumptions, we find that:

$$\frac{dp_1}{d\alpha} > 0 \quad (18)$$

$$\frac{dp_2}{d\alpha} > 0 \quad (19)$$

Thus, as the nonprofit hospital shifts more weight toward profit maximization, the prices for both firms increase. The implicit subsidy provided by the nonprofit motive creates an incentive for the nonprofit firm to price more aggressively than it would otherwise. As the nonprofit hospital places less emphasis on quantity maximization, the impact of the subsidy is less and prices for the nonprofit rise. Now, the for-profit can also extract more surplus from consumers and raise prices as well.

4.2 Model 2

Maximizing equations (5) and (6) with respect to prices and the number of uninsured patients gives:

$$\frac{\partial \pi_1}{\partial p_1} = \left(p_1 - \frac{\partial c}{\partial q_1} \right) q_1'(p_1) + q_1 = 0 \quad (20)$$

$$\frac{\partial \pi_2}{\partial p_2} = \alpha \left[\left(p_2 - \frac{\partial c}{\partial q_2^1} \right) q_2'(p_2) + q_2^1 \right] = 0 \quad (21)$$

$$\frac{\partial \pi_2}{\partial q_2^2} = -\alpha \frac{\partial c}{\partial q_2^2} + 1 - \alpha = 0 \quad (22)$$

In addition to assumptions (11)-(15), we assume that (16) and (17) hold for q_1 , q_2^1 , and q_2^2 , and that

$$\frac{\partial^2 c}{\partial q_2^1 \partial q_2^2} > 0 \quad (23)$$

$$\frac{\partial^2 c}{\partial q_2^{1^2}} \geq \frac{\partial^2 c}{\partial q_2^1 \partial q_2^2} \quad (24)$$

$$\frac{\partial^2 c}{\partial q_2^{2^2}} \geq \frac{\partial^2 c}{\partial q_2^1 \partial q_2^2} \quad (25)$$

Assumption (23) tells us that an increase in the number of uninsured patients increases the marginal cost of serving the insured patients. Given limited capacity and a limited medical staff, this assumption seems reasonable.⁴ Assumptions (24) and (25) imply that increases in the number of insured or uninsured patients served affects own marginal cost at least as much as the marginal cost of the other patient type.

Given these assumptions, it can be shown that:

$$\frac{dp_1}{d\alpha} < 0 \quad (26)$$

$$\frac{dp_2}{d\alpha} < 0 \quad (27)$$

$$\frac{dq_2^2}{d\alpha} < 0 \quad (28)$$

These results differ from those in Model 1 because the nonprofit motive is separate from the price competition between the two firms. Serving the uninsured patients does not provide an implicit subsidy to the nonprofit hospital, and therefore, they do not price as aggressively. In fact, prices for the insured patients are higher than marginal costs in order to cover the costs of serving the uninsured patients. This type

⁴A negative sign for assumption (23) would imply that serving the uninsured provides additional knowledge to medical staff or some other benefit that makes serving the insured patients less costly per patient. We consider this possibility unlikely.

of cost-shifting is discussed in detail in Dranove (1988). For-profit hospitals reap the benefits from a nonprofit in the market because they also can price above marginal cost and still be competitive with the nonprofit hospital. Therefore, as less weight is attached to the nonprofit motive, prices decrease and the number of uninsured patients served decreases as well.

4.3 Model 3

We now turn to the model where firms compete on price and quality as described in equations (7) and (8). The first-order conditions are:

$$\frac{\partial \pi_1}{\partial p_1} = \left(p_1 - \frac{\partial c}{\partial q_1} \right) q_1'(p_1) + q_1 = 0 \quad (29)$$

$$\frac{\partial \pi_1}{\partial x_1} = \left(p_1 - \frac{\partial c}{\partial q_1} \right) \frac{\partial q_1}{\partial x_1} = 0 \quad (30)$$

$$\frac{\partial \pi_2}{\partial p_2} = \alpha \left[\left(p_2 - \frac{\partial c}{\partial q_2} \right) q_2'(p_2) + q_2 \right] = 0 \quad (31)$$

$$\frac{\partial \pi_2}{\partial x_2} = \alpha \left(p_2 - \frac{\partial c}{\partial q_2} \right) \frac{\partial q_2}{\partial x_2} + (1 - \alpha) = 0 \quad (32)$$

Assumptions (11)-(17) hold in addition to the following:

$$\frac{\partial q_i}{\partial x_i} \equiv q_i'(x_i) > 0 \quad \forall i = 1, 2 \quad (33)$$

$$\frac{\partial q_i}{\partial x_j} \equiv q_i'(x_j) < 0 \quad \forall i \neq j \quad (34)$$

$$\frac{\partial q_i}{\partial x_i} > \left| \frac{\partial q_i}{\partial x_j} \right| \quad \forall i \neq j \quad (35)$$

$$\frac{\partial^2 q_i}{\partial x_i^2} = 0 \quad \forall i = 1, 2 \quad (36)$$

$$\frac{\partial^2 q_i}{\partial x_i \partial x_j} = 0 \quad \forall i \neq j \quad (37)$$

$$\frac{\partial^2 q_i}{\partial x_i \partial p_j} = 0 \quad \forall i, j = 1, 2 \quad (38)$$

$$\left| \frac{\partial q_i}{\partial p_i} \frac{\partial q_i}{\partial x_j} \right| > \left| \frac{\partial q_i}{\partial p_j} \frac{\partial q_i}{\partial x_i} \right| \quad \forall i \neq j \quad (39)$$

An increase in quality at firm i increases the demand for services at firm i , while decreasing demand at firm j . As with prices, own-quality effects are assumed stronger than cross-quality effects. In addition, a linear demand curve with respect to quality is assumed. Equation (39) states that the magnitude of difference between own- and cross-price effects is greater than the difference between own- and cross-quality effects. Thus, own-demand is more sensitive to changes in price than quality.

Now, a shift by the nonprofit toward profit maximization alters equilibrium behavior such that:

$$\frac{dp_1}{d\alpha} = 0 \quad (40)$$

$$\frac{dp_2}{d\alpha} > 0 \quad (41)$$

$$\frac{dx_1}{d\alpha} > 0 \quad (42)$$

$$\frac{dx_2}{d\alpha} > 0 \quad (43)$$

As with Model 1, the nonprofit hospital prices more aggressively due to its nonprofit motive; as it cares less about quality maximization, prices increase. However, an increase in α , increases quality. Because the firms compete on quality as well as price, more emphasis on profits provides an economic, as well as altruistic incentive, to care about quality. The for-profit hospital in order to stay competitive raises quality as well.

4.4 Competition between Two Nonprofits

Details are omitted here, but, with two exceptions, we find no qualitative difference in the market with two nonprofits competing versus competition between a nonprofit and a for-profit. For Model 2, if firm 1 has nonprofit ownership status rather than for-profit, it now puts weight on serving the uninsured. Thus, when α increases, both q_1^2 and q_2^2 increase. For Model 3, prices for firm 1 increase when α increases rather than remaining constant as shown in equation (40) when the firm has for-profit status. As with Model 2, this change is due to the new incentive on the nonprofit motive.

Note that these conclusions are only relevant for qualitative, not quantitative, differences. Thus, the presence of two nonprofits rather a nonprofit and for-profit in the market likely influences the initial equilibria, and also the magnitude of changes to these equilibria when more weight is placed on profit maximization.

5 Merger Results

We now examine how mergers in the market affect the equilibria. A common method to study mergers in a market is to maximize over the joint objective function for the merging firms. We adopt this technique here. We present results for the cases where the for-profit acquires the nonprofit hospital and where the nonprofit acquires the for-profit. For all cases, assume that marginal costs are constant.

5.1 Model 1

Now, let the for-profit acquire the nonprofit hospital. The for-profit now maximizes over the joint profit from the two hospitals such that:

$$\pi_m = \max_{p_1, p_2} p_1 q_1(p_1, p_2) + p_2 q_2(p_1, p_2) - c [q_1(p_1, p_2) + q_2(p_1, p_2)] \quad (44)$$

The first-order conditions are:

$$\frac{\partial \pi_m}{\partial p_1} = (p_1 - c)q_1'(p_1) + q_1 + (p_2 - c)q_2'(p_1) = 0 \quad (45)$$

$$\frac{\partial \pi_m}{\partial p_2} = (p_2 - c)q_2'(p_2) + q_2 + (p_1 - c)q_1'(p_2) = 0 \quad (46)$$

Comparing (45) and (46) to (9) and (10) shows that prices for both firms increase after the merger relative to the pre-merger values. Because the merged entity now cares about joint profit, it takes into account the positive cross-price effects when calculating the equilibrium prices. This positive externality is internalized after the merger and prices increase. This effect is discussed further in Deneckere and Davidson (1985) for the general case of Bertrand competition with differentiated products. Since the for-profit firm took over, the pre-merger nonprofit motive of firm 2 is no longer relevant.

Instead, let the nonprofit hospital acquire a for-profit. The merged entity maximizes (we suppress quantity as a function of prices):

$$\begin{aligned} \pi_m = \max_{p_2} \quad & \alpha [p_2 q_2(\cdot) + p_1 q_1(\cdot) - c [q_1(\cdot) + q_2(\cdot)]] \\ & + (1 - \alpha) [q_1(\cdot) + q_2(\cdot)] \end{aligned} \quad (47)$$

Maximizing with respect to p_1 and p_2 , we get:

$$\frac{\partial \pi_m}{\partial p_1} = \alpha [(p_1 - c)q_1'(p_1) + q_1 + (p_2 - c)q_2'(p_1)]$$

$$+(1 - \alpha)(q'_1(p_1) + q'_2(p_1)) = 0 \quad (48)$$

$$\begin{aligned} \frac{\partial \pi_m}{\partial p_2} &= \alpha [(p_2 - c)q'_2(p_2) + q_2 + (p_1 - c)q'_1(p_2)] \\ &+ (1 - \alpha)(q'_1(p_2) + q'_2(p_2)) = 0 \end{aligned} \quad (49)$$

As with the for-profit merger, p_2 increases from the pre-merger price given by equation (10). The nonprofit motive to maximize output, combined with the cross-price effect, serves to reinforce the incentive to increase prices. An increase in prices for firm 2 increases output at firm 1, increasing the total number of patients served by both hospitals.

Post-merger prices for firm 1, defined as p_1^A , are less clear. Solving for p_1^A in (48) and pre-merger prices, (p_1^B), in (9) and assuming constant marginal costs gives:

$$p_1^A = c - \frac{q_1}{q'_1(p_1)} - (p_2 - c) \frac{q'_2(p_1)}{q'_1(p_1)} - \frac{(1 - \alpha)}{\alpha} \left(\frac{q'_2(p_1)}{q'_1(p_1)} + 1 \right) \quad (50)$$

$$p_1^B = c - \frac{q_1}{q'_1(p_1)} \quad (51)$$

In (50), the third and fourth terms represent the positive externality to firm 2 if firm 1 raises prices. Both are negative while the last term, which is the nonprofit motive of firm 1, is positive. Prior to the merger, firm 1 did not care about output maximization. Now that the nonprofit motive for firm 1 is part of the joint objective function, the change to prices is ambiguous. If the merged entity values increased output at firm 2 more than at firm 1, then $p_1^A > p_1^B$ while the reverse is true if output is valued more at firm 1. Presumably, much of this decision depends on factors that

are not present in this simplified model. For example, firm 1 and 2 may be in the same market, but firm 1 may be located in a more populated area. Under this scenario, more benefit is derived from a decrease in p_1^A . Thus, the decision to raise or lower prices at the former for-profit hospital is highly influenced by the specific geographic and individual circumstances of the two merging hospitals.

5.2 Model 2

Due to the separation between the nonprofit motive and profit maximization, the changes in equilibrium behavior when a merger occurs are intuitive for the second model. The joint objective function for the merged entity if the for-profit acquires the nonprofit or the nonprofit acquires the for-profit are respectively:

$$\pi_m = \max_{p_1, p_2} p_1 q_1(p_1, p_2) + p_2 q_2(p_1, p_2) - c[q_1 + q_2] \quad (52)$$

$$\begin{aligned} \pi_m = \max_{p_1, p_2, q_1^2, q_2^2} & \alpha [p_1 q_1^1(p_1, p_2) + p_2 q_2^1(p_1, p_2) - c[q_1^1(p_1, p_2) + q_2^1(p_1, p_2) \\ & + q_1^2 + q_2^2]] + (1 - \alpha)(q_1^2 + q_2^2) \end{aligned} \quad (53)$$

For both types of mergers, the positive externality from a price increase is internalized, and therefore, prices increase for both firms. If the for-profit acquires the nonprofit, the merged for-profit no longer cares about serving the uninsured at firm 2. Conversely, an acquisition by the nonprofit hospital would create a nonprofit motive of serving the uninsured at firm 1. Because the two firms do not compete based on the number of uninsured served, there are no externalities to consider when the merger occurs. Thus, the number of uninsured patients served at firm 2 remains at

its pre-merger level and the total number of uninsured served increases.

5.3 Model 3

The joint objective function and first-order conditions when the nonprofit merges into the for-profit hospital are:

$$\begin{aligned} \pi_m = \max_{p_1, p_2, x_1, x_2} & p_1 q_1(p_1, p_2, x_1, x_2) + p_2 q_2(p_1, p_2, x_1, x_2) \\ & - c [q_1(p_1, p_2, x_1, x_2) + q_2(p_1, p_2, x_1, x_2)] \end{aligned} \quad (54)$$

$$\frac{\partial \pi_m}{\partial p_1} = (p_1 - c)q'_1(p_1) + q_1 + (p_2 - c)q'_2(p_1) = 0 \quad (55)$$

$$\frac{\partial \pi_m}{\partial x_1} = (p_1 - c)q'_1(x_1) + (p_2 - c)q'_2(x_1) = 0 \quad (56)$$

$$\frac{\partial \pi_m}{\partial p_2} = (p_2 - c)q'_2(p_2) + q_2 + (p_1 - c)q'_1(p_2) = 0 \quad (57)$$

$$\frac{\partial \pi_m}{\partial x_2} = (p_2 - c)q'_2(x_2) + (p_1 - c)q'_1(x_2) = 0 \quad (58)$$

Results for this merger are as expected when compared to the first-order conditions (29)-(32). When the for-profit acquires the nonprofit hospital, prices rise and quality declines for both firms.

While price changes are the same if the nonprofit is the acquirer rather than the for-profit, the results are quite different for quality. The objective function and first-order conditions for the merged entity are (we suppress quantity as a function of prices

and quality):

$$\begin{aligned} \pi_m &= \max_{p_1, p_2, x_1, x_2} \alpha [p_1 q_1(\cdot) + p_2 q_2(\cdot) - c [q_1(\cdot) + q_2(\cdot)]] \\ &\quad + (1 - \alpha)(x_1 + x_2) \end{aligned} \quad (59)$$

$$\frac{\partial \pi_m}{\partial p_1} = \alpha [(p_1 - c)q_1'(p_1) + q_1 + (p_2 - c)q_2'(p_1)] = 0 \quad (60)$$

$$\frac{\partial \pi_m}{\partial x_1} = \alpha [(p_1 - c)q_1'(x_1) + (p_2 - c)q_2'(x_1)] + (1 - \alpha) = 0 \quad (61)$$

$$\frac{\partial \pi_m}{\partial p_2} = \alpha [(p_2 - c)q_2'(p_2) + q_2 + (p_1 - c)q_1'(p_2)] = 0 \quad (62)$$

$$\frac{\partial \pi_m}{\partial x_2} = \alpha [(p_2 - c)q_2'(x_2) + (p_1 - c)q_1'(x_2)] + (1 - \alpha) = 0 \quad (63)$$

For firm 2, the effect is unambiguous; quality declines when the for-profit hospital merges into the nonprofit hospital. This effect is due to the negative externality on firm 1's output when firm 2 raises quality. This externality is ignored prior to the merger, but is internalized when maximizing the joint objective function.

A closer investigation is required to determine the influence of the merger on firm 1's quality. Comparing (61) to (30), we find that the negative externality is at odds with the nonprofit motive. Prior to the merger, the for-profit hospital did not consider quality maximization an objective of the firm. This added objective post-merger encourages higher quality of services. However, an increase in quality negatively affects the demand for firm 2's services. If the merged entity values output at firm 1 more than at firm 2, then quality will increase for firm 1. Otherwise, quality

declines. As with prices in Model 1 when the nonprofit acquires the for-profit, this decision will be firm specific.

6 Conclusion

In this paper, we use three simple theoretical models of nonprofit hospitals to investigate equilibrium behavior when hospitals compete and merge. In particular, the nonprofit objective function is a linear combination of profit maximization and some nonprofit motive. We examine how prices, quantity of patients served, and quality of care are affected as nonprofits place more weight on profit maximization. We find that the specification of the nonprofit motive influences the results. When nonprofit hospitals care about serving the uninsured, prices fall as the market becomes more competitive. However, when hospitals compete on price and quality and the nonprofit motive is quality maximization, prices and quality rise as the nonprofit cares more about profit maximization.

In addition and contrary to popular belief, the presence of a nonprofit motive does not preclude competitive behavior when a merger occurs. When a nonprofit acquires a for-profit hospital, we find that even if the nonprofit is pursuing objectives other than profit maximization, prices for the acquiring hospital unambiguously rise after a merger. Prices for the acquiree also rise unless the nonprofit motive is output maximization and the merged entity values output at the acquired hospital more than at the acquiring hospital. We also find that, due to nonprice competition, quality of care decreases for the nonprofit hospital if a merger occurs.

This paper is merely a first step to examining nonprofit and for-profit hospital competition. In this paper, the parameter (α) determining the nonprofit hospitals' weight on profit maximization is taken as given. We do not address the question of how nonprofit hospitals choose α . Development of a two-stage game where hospitals choose prices and also α would give additional insight into the industry. In addition, the models described above could be empirically modelled in order to estimate α . An α close to 1 would indicate that the nonprofit does not care about the nonprofit motive and can be treated as a profit maximizer. This type of modeling may also be extended to other industries where nonprofits and for-profits compete. Given the recent rise of credit unions in banking and for-profits in the education industry, such investigation is warranted.

References

- [1] Alexander, Jeffrey A., Michael T. Halpern, and Shoou-Yih D. Lee, (1996). "The short-term effects of mergers on hospital operations," *Health Services Research*, 30(6), 827-847.
- [2] Blackstone, Erwin A. and Joseph P. Fuhr, (1993), "An Antitrust Analysis of Non-profit Hospital Mergers," *Review of Industrial Organization*, 8(4), 473-490.
- [3] Cutler, David M. and Jill R. Horwitz, (2000), "Converting Hospitals from Not-for-Profit to For-Profit Status: Why and What Effects?" David M. Cutler, ed. in *The Changing Hospital Industry: Comparing Not-for-Profit and For-Profit Institutions*, Chicago: University of Chicago Press, 45-92.
- [4] Deneckere, Raymond and Carl Davidson, (1985), "Incentives to Form Coalitions with Bertrand Competition," *Rand Journal of Economics*, 16(4), 473-486.
- [5] Dranove, David, (1988), "Pricing by Non-Profit Institutions," *Journal of Health Economics*, 7, 47-57.
- [6] Dranove, David and Mark A. Satterthwaite, (2000), "The industrial organization of health care markets," Anthony J. Culyer and Joseph P. Newhouse, eds. in *Handbook of Health Economics*, Amsterdam: Elsevier.
- [7] Dusansky, R. and P.J. Kalman, (1974), "Toward an Economic Model of the Teaching Hospital," *Journal of Economic Theory*, 7, 210-223.
- [8] Irving Levin Associates, (2000), *The Hospital Acquisition Report*, Irving Levin Associates, Inc.
- [9] Long, M.F., (1964), "Efficient Use of Hospitals," S.J. Axelrod, ed. in *The Economics of Health and Medical Care*, Ann Arbor, 211-26.
- [10] Lynk, William J., (1995a). "The creation of economic efficiencies in hospital mergers," *Journal of Health Economics*, 14, 507-530.
- [11] Lynk, William J., (1995b). "Nonprofit hospital mergers and exercise of market power," *Journal of Law and Economics*, 38, 437-461.
- [12] Melnick, Glenn A., Jack Zwanziger, Anil Bamezai, and Robert Pattison, (1992). "The effects of market structure and bargaining position on hospital prices," *Journal of Health Economics*, 11, 217-233.
- [13] Melnick, Glenn, Emmett Keeler and Jack Zwanziger, (1999). "Market power and hospital pricing: Are nonprofits different?," *Health Affairs*, 18(3), 167-173.
- [14] Newhouse, Joseph P., (1970), "Toward a Theory of Nonprofit Institutions: An Economic Model of a Hospital," *American Economic Review*, 60(1), 64-74.

- [15] Pauly, Mark and Michael Redisch, (1973), “ The Not-For-Profit Hospital as a Physicians’ Cooperative,” *American Economic Review*, 63(1), 87-99.
- [16] Phillips, Janet F., (1999), “For-profit chains seek to acquire successful not-for-profit hospitals,” *Healthcare Financial Management*, 53(9), 52-55.
- [17] Steinberg, Richard, (1986), “The revealed objective function of nonprofit firms,” *Rand Journal of Economics*, 17(4), 508-526.