Competition Between not-for-profit and for-profit Hospitals in Small Markets

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ABSTRACT: This paper examines the relationship between how hospital ownership is organized and the intensity of competition in the health care market. I study the question using an empirical entry model. These models typically exhibit multiple equilibria. To resolve this problem, a novel algorithm that computes all the equilibria of the game is developed. This paper uses the algorithm together with two different equilibrium selection rules to estimate the parameters of interest. My findings suggest that for-profit and not-for-profit hospitals can be regarded as supplying a differentiated products. I use my estimates to simulate two counterfactuals. First, I study a market were only not-for-profit hospitals exists. The results suggest a decrease in the level of health services. Second, I study a market were not-for-profit firms do not enjoy any tax shelters. I again find a decrease in the level of health services. I conclude that mixed markets are beneficial to consumers.

Key words: health care system, profit and not-for-profit hospitals , multiple equilibria econometrics
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1. Introduction

The hospital sector in the United States is served by for-profit , not-for-profit , and public firms. It is also the largest sector of the nonprofit economy accounting for 40% of its revenue (Duggan, 2002). Section (501)(c)(3) of the internal revenue code exempts not-for-profit organizations from Federal income tax obligations in return for the supply of charity and other community benefits. Estimates of the forgone tax revenue from the not-for-profit hospital sector are known to reach 4.6 billion dollar (Gentry and Penrod, 1998). In addition, the skyrocketing costs of Medicare and Medicaid led researchers and policy makers to ask whether for-profit and not-for-profit hospitals are really different from each other. In this paper, I use an empirical entry model to analyze the competitive behavior between for-profit and not-for-profit firms in the hospital market.

Although some literature has tried to answer this question, its main theme has been to determine whether not-for-profit firms behave differently in the presence of for-profit firms[1]. Unlike previous research, I endogenize the decision of both for-profit and not-for-profit firms in the hospital sector. I am not only interested in the effect of for-profit firms on their not-for-profit counterpart, but am also interested in the effect of not-for-profit firms on their for-profit counterparts.

The main findings of the paper can be summarized as follow; First,the intensity of competition is higher when two firms have the same ownership type. This suggests that ownership type matters and for-profit and not-for-profit hospitals can be regarded as supplying a differentiated product. Second, the model suggests that for-profit hospitals have a larger competitive effect on not-for-profit hospitals. Not-for-profit hospitals do not seem to deter the entry of for-profit hospitals as much as for-profit hospitals deter the entry of their not-for-profit counterparts. I also perform two counterfactuals, one in which I disallow not-for-profit hospitals from entering the market, and another in which I disallow entry by for-profit hospitals. The model predicts a higher level of health care services in market that have both for-profit and not-for-profit hospitals.

[1]See Duggan (2002), Cutler and Horwitz (1999), Silverman and Skinner (2001)

The paper uses a simple simultaneous move entry model to uncover the relationship between organizational form and competition. The model assumes two stages, with many players, each of whom has either a not-for-profit or a for-profit ownership form. In the first stage, all potential firms make entry decisions. In the second stage, entrants compete to provide health care services. I only consider pure strategy Nash equilibrium solutions. In general, the entry game has multiple solutions. This multiplicity leads to a problem in the estimation of the behavioral parameters. In particular, Multiplicity of equilibria predict different probability distributions for the data for a given set of parameters. Therefore, maximum likelihood is not feasible because the likelihood function is not well defined. To resolve this problem, the paper develops a novel and extremely simple algorithm to compute all the equilibria of the game. The paper uses the algorithm together with two different equilibrium selection rules to estimate the model and reach its conclusions.

1.1 Theoretical literature of the impact of ownership type

A not-for-profit hospital is defined as any hospital that is subject to section (501)(c)(3) of the Internal Revenue Code. These are hospitals that are owned by their communities and not by shareholders or investors. They are restricted from using the equity market, but are are allowed to receive donations and issue tax exempt bonds. They are obligated to reinvest all their accounting profits in their organization and their community. The Internal Revenue Code recognizes their mission by exempting them from income and sometimes property taxes.

A for-profit hospital is any hospital that is organized as sole proprietorship, partnership, or a corporation. It is subject to state, and federal tax laws just as any other for-profit firm. It is not restricted from the equity market and therefore can raise capital for its financing needs at a faster rate than any of its not-for-profit counterpart.

The difference in these financial constraints do not directly imply that for-profit and not-for-profit firms produce a differentiated product. There are however a number of reasons why one might think consumers value these ownership types differently.

Arrow (1963) outlines the failure of the free economic system in incomplete markets and concludes that not-for-profit organizations might be the socially-optimal response in these markets. This is also the general conclusion in Easley and O'Hara (1983); Glaeser and Shleifer (2001); Hansmann (1980, 1987, 1996); Weisbrod (1977, 1988). In these models, market imperfection is captured by the unobservable quality attribute of the product the consumer purchases. Since not-for-profit hospitals are not owned by investors, they might not be willing nor able to pursue profit maximization. Therefore, consumers are more willing to contract with a not-for-profit hospital because they believe the latter won't undercut the provision of quality once the contract is signed.

However, there is also a body of theoretical literature that argues the not-for-profit organizational form might be at most as good as the for-profit form, even though markets are incomplete. This is the general view in Newhouse (1970); Feldstein (1971); Pauly and Redish (1973). These models either rely on the assumption that a not-for-profit hospital maximizes both quantity and quality or that a not-for-profit hospital is governed by managers that are maximizing their own salaries, bonuses and as such the organization behaves similar to a for-profit hospital.

In addition, consumers might value these organizational types differently for many other reasons. For example, a consumer is altruistic in her behavior and is willing to contract with a not-for-profit as opposed to a for-profit organization because she believes the not-for-profit institution reinvest its revenues in the community.

Another possibility is that differentiation is driven by cost differences between for-profit and not-for-profit hospitals. Due to tax advantages, not-for-profit hospitals supply products that are regarded non-profitable by their for-profit counterpart. This will prevent for-profit hospitals from supplying these particular products. Thus consumers might value ownership types on a verifiable dimension.

Although the arguments above might sound compelling, there are a number of reasons why we can reject them; Reputation might drive for-profit firms to stay true to the nature of the contract. In addition, consumers might have enough information to contract with any firm. This is particularly convincing in an age where information is almost freely obtained[2].

1.2 Empirical literature of the impact of ownership type

From the empirical literature, there is evidence suggesting that consumers do not differentiate between the two ownership forms. Mauser (1993) studies the day care industry and finds that consumers are not aware of the ownership type of the center where they purchase their services.

A few empirical papers analyze the behavior of for-profit and not-for-profit hospitals. Duggan (2002) exploits California's Disproportionate Share incentive program to analyze the behavior of not-for-profit hospitals. The author finds that in areas where for-profit firms are present, not-for-profit hospitals behave more alike their for-profit counterpart. Norton and Staiger (1994) find that when for-profit and not-for-profit hospitals locate in the same area, they both tend to supply the same level of charities. So far the literature has not analyzed the effect of the not-for-profit hospitals on their for-profit counterpart. In this paper, I fill this particular gap in the literature. Numerous countries are having debates on whether to allow for-profit hospitals into the market. A complete debate should take the strategic behavior between for-profit and not-for-profit hospitals.

In addition, most studies conducted so far try to use a proxy for the price of health care to estimate a supply or a demand curve. These proxies contain mismeasurement, and are subject to the usual criticism that any mismeasurement in price or charity might lead to biased and inconsistent estimates of the competitive or behavioral parameters (Bresnahan, 1989; Schmalensee, 1989) .

To overcome the measurement problem, Abraham, Gaynor, and Vogt (2005) study the hospital market structure from an entry game model. The authors augment the methodology developed in Bresnahan and Reiss (1988, 1990, 1991) and introduce quantity to the model. They find that entry leads to markets that are quickly becoming competitive. Their model does not suffer from the measurement draw back mentioned above, however they are not

[2] This is true because the Internet made it almost costless to obtain information

able to differentiate between for-profit and not-for-profit hospitals. Their model assumes that for-profit and not-for-profit firms are identical.

In this paper I address these issues and analyze the market structure in the hospital sector by also using an empirical entry model. However, unlike Abraham *et al.* (2005), I do not assume that firms are identical. Instead, I assume that firms are heterogeneous and belong to either a for-profit or a not-for-profit type. I also assume that hospitals are heterogeneous within each type. The problem of the hospital is to locate in a market and compete with other hospitals. I find evidence that organizational form matters and for-profit and not-for-profit hospitals can be regarded as supplying a differentiated product. The findings also suggest that the competitive effect of a for-profit hospital on its not-for-profit counterpart is larger than that of not-for-profit hospital on its for-profit counterpart. Finally, restricting one of the for-profit or not-for-profit forms from entering the market, the model predicts a decrease in the level of health care services. I conclude that markets that have both for-profit and not-for-profit hospitals have higher levels of health care services than ones with only one type.

The outline of the paper is organized as follow. Section 2 discusses the model, section 3 discusses the methodology, section 4 presents the data, section 5 presents the results, and section 6 concludes. Some proofs and data description are given in the appendices.

2. The Model

The setup I consider in this paper is one in which the researcher observes the hospital type, its location, and some market characteristics where the hospital operates. I only model the decision of private For-Profit (FP) and private Not-For Profit (NFP) hospitals. I take as exogenous the decisions of non-Federal hospitals, and ignore the decision of the Federal ones as they do not serve the general public. I also assume organizational type is given exogenously. The decision of a hospital is to enter the market and compete with other hospitals.

The model is a simultaneous move two-stage game with complete information. In each market there are $\mathbb{N}^{\text{nfp}}$, and $\mathbb{N}^{\text{fp}}$ potential NFP and FP entrants respectively. Let a_i^j, $j = \{\text{nfp}, \text{fp}\}$ denote an action for hospital i of ownership type j. In the first stage each potential NFP (FP) hospital simultaneously chooses an action a_i^{nfp} (a_i^{fp}) from the set $A_i^{\text{nfp}}(A_i^{\text{fp}}) = \{\textit{do not enter}, \textit{enter}\}$. For notational convenience and following the empirical literature on discrete games, I denote "do not enter " by 0, and "enter " by 1. In the second stage, hospitals that chose to enter compete and realize their post entry payoffs. I do not postulate the nature of competition in the second stage[3]. Define $\mathbb{A} = \times_{i,j} A_i^j$, and let $a = \{a^{\text{nfp}}, a^{\text{fp}}\}$ denote an element of $\mathbb{A}$, where $a^{\text{nfp}} = \{a_1^{\text{nfp}}, a_2^{\text{nfp}}, \cdots, a_{\mathbb{N}^{\text{nfp}}}^{\text{nfp}}\}$, and $a^{\text{fp}} = \{a_1^{\text{fp}}, a_2^{\text{fp}}, \cdots, a_{\mathbb{N}^{\text{fp}}}^{\text{fp}}\}$. Let $a_{-i}^j = \{a \diagdown a_i^j\}$ denote the list of actions in profile a except for firm i of ownership type j. Similarly, let $a^{-j} = \{a \diagdown a^j\}$denote the list of actions of all firms that are not of type j in profile a. Let $N_i^j = \sum_{k \diagdown i}^{j} a_k^j$, and $N^{-j} = \sum_{k=1}^{-j} a_k^{-j}$, the number of competitors of firm i of ownership type j that are of the same type and the other type respectively in the action profile a[4]. While firms know all relevant information regarding their entry decision, the econometrician does not and thus is left to model the unobservables. let X denote the market covariates. In each market, the payoff function of an entrant is given by

$$\tilde{\pi}_i^j(a,X,\beta,\theta,\epsilon_i^j) = X\beta^j + f(\theta^j, N^{-j}, N_{-i}^j) - \epsilon_i^j. \tag{1}$$

For notational convenience, I will denote $\tilde{\pi}_i^j(a,X,\beta,\theta,\epsilon_i^j)$ simply by $\tilde{\pi}_i^j(a)$. In Equation 1, β^j denote the marginal effects of the market characteristics on firm i's payoffs, which can also depend on the ownership type of the hospital. $f(\theta^j, N^{-j}, N_{-i}^j)$ represents the effect of the actions of all other firms on firm i's payoff. It is assumed continuously decreasing in both N^{-j},and N_{-i}^j. Finally, ϵ_i^j is a random payoff shock, and it reflects information about the payoff that is common knowledge to all market participants but is not observed by the econometrician. I normalize the payoff from not entering a market to zero for both ownership types.

[3]This strategy is followed by Abraham *et al.* (2005); Bresnahan and Reiss (1990, 1991); Berry (1992), and others

[4]Since the available actions for every firm are either 0 or 1 where 1 denote entry, summing over the actions gives us the number of entrants in profile a

2.1 Solution of the Model

I only consider Pure Strategy Nash Equilibrium (PSNE) solutions to the game. These solutions are given by a set of actions where no firm is willing to deviate from its action given the actions of all other firms. In these solutions, I observe entrants if and only if they expect to make nonnegative payoffs. Formally, a PSNE is a profile $a^{\star} = \left(a^{\star,\text{nfp}}, a^{\star,\text{fp}}\right)$ that satisfies the following conditions:

$$a_i^{j,\star}\ \tilde{\pi}_i^j(a^{\star}) \geq 0 \qquad \tilde{\pi}_i^j(a^{\star}) \leq 0, \quad \text{for all} \quad i = 1, \cdots \mathbb{N}, \quad j = \{\text{nfp}, \text{fp}\}, \tag{2}$$

and

$$\left(1 - a_i^{j,\star}\right) \qquad \tilde{\pi}_i^j(a^{\star}) \leq 0, \quad \text{for all} \quad i = 1, \cdots \mathbb{N}, \quad j = \{\text{nfp}, \text{fp}\}. \tag{3}$$

The above inequalities simply state that a firm of either type will enter the market if and only if it expects nonnegative payoffs. To see this, suppose firm i of type j enters the market. In this case $a_i^{\star,j} = 1$, and its payoffs must be nonnegative. Since firm i entered the market, we know that $\tilde{\pi}_i^{j,\star}(a^{\star}) \geq 0$. In addition, we know that $(1 - a_i^{j,\star}) = 0$, which implies that $(1 - a_i^{j,\star})\tilde{\pi}_i^{j,\star}(a^{\star}) = 0$. Therefore conditions 2 and 3 are satisfied. Now suppose that firm i of type j does not enter the market. We have $a_j^{\star,\text{nfp}} = 0$, ,and its payoff $\tilde{\pi}_i^j(a^{\star}) = 0$, the outside option. Thus both conditions are again satisfied.

Lemma this model will always have an equilibrium.

Proof is given in appendix Appendix .1. The proof is constructed by showing that I can always find an equilibrium in this model. However, the model does not predict a unique equilibrium.

3. Methodology

In order to estimate the model, I require a cross section of markets where I observe different entry decisions. As stated earlier, the model exhibits multiple equilibria, thus predicts different probability distributions for the data for a given set of parameters. Maximum Likelihood is not feasible because the likelihood function is not well defined.

To further clarify these ideas, consider a simple example where we have two potential hospitals, one of each type. Let $\{\Delta^{\text{nfp}}, \Delta^{\text{fp}}\}$ denote the effect of the for-profit on the not-for-profit and the effect of the not-for-profit on the for-profit hospital respectively. The Δ's represent the difference between a monopolist and a duopolist payoff; Naturally they are negative. Consider a single market, and let $\pi^j = X\beta^j - \epsilon^j$ denote the part of the payoff that does not depend on competition. The payoff matrix of this simple setup is given by

		FP: Entry	FP: No Entry
NFP	Entry	$\pi^{\text{nfp}} + \Delta^{\text{nfp}}$, $\pi^{\text{fp}} + \Delta^{\text{fp}}$	π^{nfp} , 0
	No Entry	0 , π^{fp}	0 , 0

This game can also be stated as an endogenous dummy variable problem where the choice of entry is given as

$$a^i = \begin{cases} \text{Enter if } \; X\beta^j + \mathbb{I}(-j \text{ enters}) \times \Delta^j - \epsilon^j \geq 0 \\ \text{Do not enter, otherwise} \end{cases}$$

Where, $\mathbb{I}(-j \text{ enters})$ denotes the indicator variable that takes the value 1 if the other hospital enters the market. The above structural equation shows the similarities between empirical entry game models and Heckman (1978) dummy endogenous variables in simultaneous equations model. Heckman (1978) gives necessary and sufficient conditions under which the model predicts a unique reduced form. In the current set up, these conditions make the model recursive i.e. having one of the competitive effects Δ^j set to zero. However, the current paper is interested in uncovering those particular parameters, therefore the recursive solution cannot do.

Figure 1. shows the solution of the simple two player game described above. The horizontal axis plots the not-for-profit unobservable, while the vertical axis plots the for-profit unobservable. $\tilde{\epsilon}^i = \left\{\tilde{\epsilon}^{\text{nfp}}, \tilde{\epsilon}^{\text{fp}}\right\}$ are the level of unobservables that make the hospitals indifferent

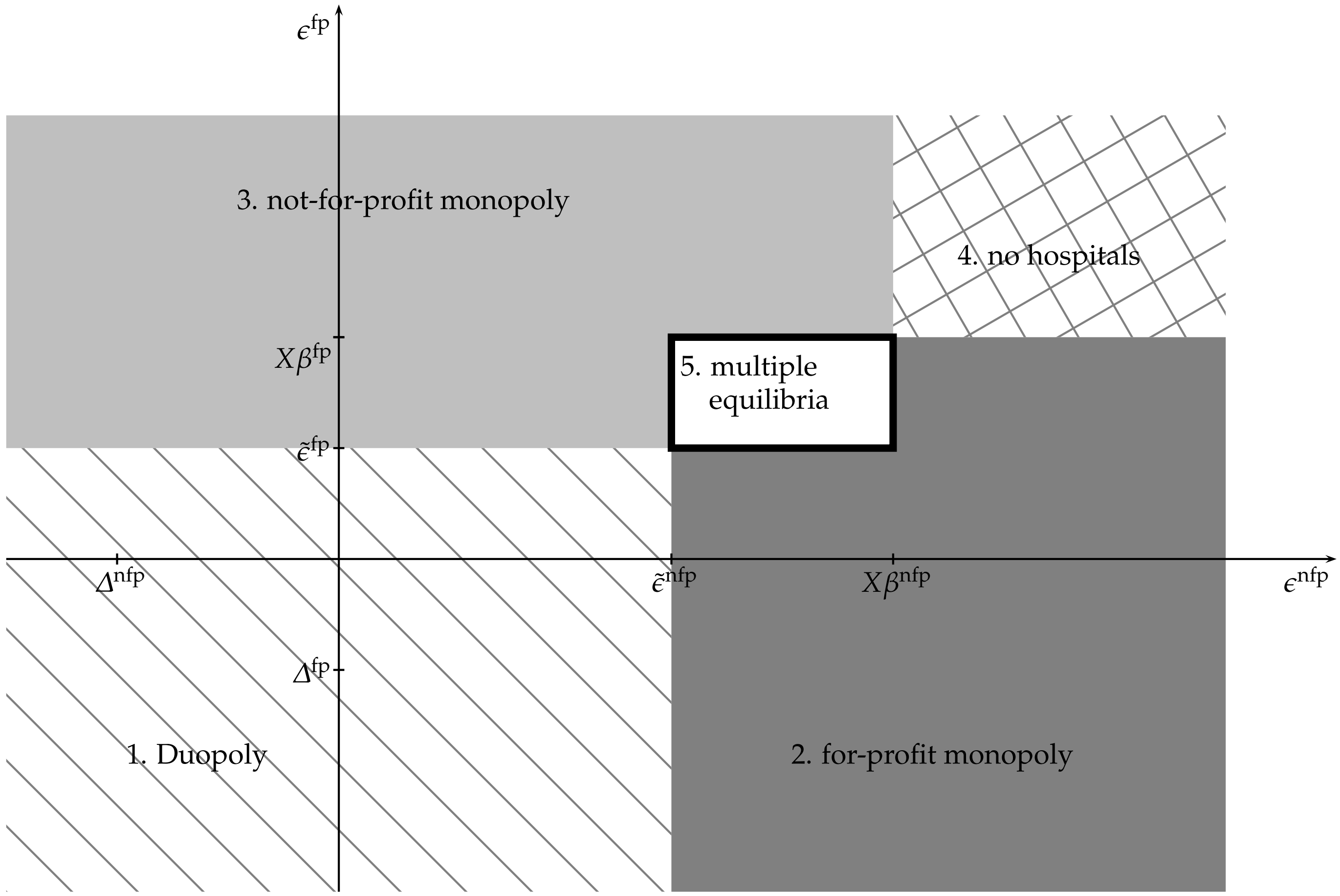

Figure 1. Simple solution to the 2×2 game. This figure assumes that $X\beta^{\text{nfp}} > X\beta^{\text{fp}}$, i.e. market covariates affect the not-for-profit hospital more than they do the for-profit hospital. Furthermore, the effect of the for-profit hospital on the not-for-profit hospital is greater than the effect of the not-for-profit hospital on the for-profit hospital; $|\Delta^{\text{nfp}}| > |\Delta^{\text{fp}}|$

between entry and no entry under a duopoly market[5]. Figure 1 assumes the not-for-profit hospital is more sensitive to the observed market characteristics; $X\beta^{\text{nfp}} > X\beta^{\text{fp}}$. We have multiple equilibria when either hospital wants to enter the market as a monopolist but chooses not to enter under a duopoly structure. This is given by region 5 in the figure where we have $X\beta^{\text{nfp}} - \epsilon^{\text{nfp}} > 0, X\beta^{\text{nfp}} + \Delta^{\text{nfp}} - \epsilon^{\text{nfp}} < 0,$ and $X\beta^{\text{fp}} - \epsilon^{\text{fp}} > 0, X\beta^{\text{fp}} + \Delta^{\text{fp}} - \epsilon^{\text{fp}} < 0.$

[5]These are the solutions to the following equations system

$$\begin{array}{ccccccc} X\beta^{\text{nfp}} & + & \Delta^{\text{nfp}} & + & \tilde{\epsilon}^{\text{nfp}} & = & 0 \\ X\beta^{\text{fp}} & + & \Delta^{\text{fp}} & + & \tilde{\epsilon}^{\text{fp}} & = & 0 \end{array}$$

Thus, for a range of the unobservables, the model predicts that one of the for-profit or not-for-profit hospital enters the market but not both. In the rest of the figure the model predicts unique equilibria. Region 1 has $X\beta^j + \Delta^j - \epsilon^j >= 0$ for $j = \{\text{nfp}, \text{fp}\}$, therefore both hospitals will enter. The payoffs in region 4 do not support a monopolist of either type; $X\beta^{\text{fp}} - \epsilon^{\text{fp}} < 0$, and $X\beta^{\text{nfp}} - \epsilon^{\text{nfp}} < 0$. Region 2, can only support an for-profit monopolist, while region 3 can only support an not-for-profit monopolist. It is region 5 in figure 1 that does not allow for a simple maximum likelihood estimation. The difficulties arise when assigning the likelihood in this region. In this simple setup, I can uniquely assign the probability of observing a duopoly or zero hospital market structure. However, the probability of observing either a for-profit or a not-for-profit monopolist is not well defined. A naive maximum likelihood estimation double counts region 5, making the probability of observing the entire sample space larger than one.

The first research that empirically analyzed a market through a game theoretic approach is that of Bjorn and Vuong (1985). The authors analyze labour decisions of married couples. To solve the problem of multiple equilibria, the authors index the continuum of equilibria with a finite set of parameters and estimate their model. The likelihood function becomes a mixture of these equilibria. Their paper studies a two player model, and has at most 3 equilibria. Therefore, adding three more parameters to estimate is feasible. In more complicated models, those where there are more than two players, this solution becomes more complicated and sometimes computationally impossible. This is indeed the case in the current paper, where I have 1201 players simultaneously choosing entry, therefore Bjorn and Vuong (1985) method cannot be used.

Bresnahan and Reiss (1988, 1991) study a symmetric entry game with identical hospitals. To solve the multiplicity of equilibria problem, they concentrate on the number of hospitals the model predicts. If I only concentrate on the number of hospitals in the market but not their type, figure 1 shows that the model predicts a unique equilibrium. Regions 2, 3, and 5 all predict monopoly, region 1 predicts duopoly, and region 4 predicts zero hospital market structure. Therefore, the entire sample space can be partitioned by the observable outcomes of the data, and maximum likelihood is feasible and becomes a simple ordered probit model. Abraham *et al.* (2005) augment the framework developed in Bresnahan and Reiss (1988, 1991) by including a quantity variable and study competition between hospitals in the United States. They also use the same strategy to overcome the multiple equilibria problem. Unfortunately, they cannot estimate the parameters of interest the current paper is interested in. In their work, all hospitals are identical, and there are no differences between for-profit and not-for-profit hospitals.

Berry (1992) introduces heterogeneity in the fixed costs portion of the profit function of airlines operating in a city pair, but still assumes that hospitals are symmetric in variable profits. His model also predicts a unique equilibrium in the number of hospitals. In Berry (1992), the number of hospitals no longer follows an ordered probit model[6] and maximum likelihood is computationally cumbersome. The author uses the simulated method of moments to estimate his model.

In the current study, variable profits are asymmetric due to the ownership type of the hospitals. This is modelled by introducing the function $f(\theta^j, N_i^j, N^{-j})$ in the profit function. Unfortunately, this setup does not lead to a unique prediction of the model as in Berry (1992), Bresnahan and Reiss (1988, 1991), or Abraham *et al.* (2005). Thus, the solutions suggested above cannot be applied.

Mazzeo (2002) studies entry of low and high quality motels on the interstate highway. As opposed to Berry (1992), the author augments Bresnahan and Reiss (1988, 1991) by introducing heterogeneity in the variable profits. However, this heterogeneity is in the type of motel the hospital chooses to build. The author still assumes that hospitals are identical within each type. A set of assumptions are made to predict a unique equilibrium[7]. The author maximizes the likelihood of observing the tuples that make up the number of motels of each type in the market. The author is interested in the magnitude of differentiation between low quality and high quality motels, and as such the setup does not allow for the possibility

[6] This is due to the fact that hospitals are assumed heterogeneous within and across markets

[7] The author divides the decision of the hospital into two stages. One that chooses the type and one that chooses entry.

of analyzing a homogeneous product. The model becomes ill defined when analyzing a homogeneous product, and it predicts zero probability of observing any market structure. Since the current paper is interested in uncovering whether for-profit and not-for-profit hospitals are differentiated, the latter solution does not apply.

More recently Bajari, Hong, and Ryan (2004) propose to estimate the equilibrium selection rule and hospital payoff function through exclusion restrictions similar to those used in the treatment effect and sample selection models. They use Gambit (McKelvy and McLennan, 1996) to compute all the equilibria of the game. Gambit is a "library of game theory software and tools for the construction and analysis of finite extensive and strategic games"[8].However, as the number of players increase, it becomes harder and in fact impossible for Gambit to find all the equilibria of the game. Ackerberg and Gowrisankaran (2003) also estimate the selection rule for multiple equilibria under the assumption that either the Pareto best or worst equilibria will be played. Their likelihood is a weighted average of the likelihoods associated with these two equilibria.

In addition, to the solutions presented above, other authors have used incomplete information games to help alleviate the multiplicity of equilibria problem. Seim (2001) studies an incomplete information model where she analyzes the location of video retail stores. However, the author cannot assert a unique equilibrium of the model[9]. Sweeting (2004) exploits the presence of the multiple equilibria in an imperfect information game to identify his model. The model has at most two equilibria, and unlike previous research, the author suggests that different equilibria are played in different markets. Because the author observes these equilibria in different markets, he gains stronger identification.

There is also some literature that is trying to estimate these models under minimal imposed structure. Some of these papers are Tamer (2002, 2003), Manski and Tamer (2002), Andrews, Berry, and Jia (2004), Ciliberto and Tamer (2003). In this literature, a set of inequalities bounding the probability of predicting the equilibria of the model, together with

[8]http://econweb.tamu.edu/gambit/

[9]The author presents a proof of uniqueness and existence under a simplified version of the model together with some restrictions on the parameters. the author can only show simulation evidence for the general case.

an appropriate distance function, give rise to estimates of sets rather than points for the parameters of interest. For example the probability of observing a not-for-profit hospital is bounded below by region 3 in figure 1, and bounded above by the union of region 3 and 5 in figure 1. The estimation strategy is to find all parameter values that satisfy these inequalities. Borzekowski and Cohen (2005) use this methodology together with some intuitive simplifying assumptions to estimate a game with strategic complementarities. They study the decision to outsource the Information technology services for the US credit unions. However, their model takes the location of these credit unions as exogenous thus simplifying the estimation considerably. Due to the large number of hospitals in my model, and the endogenous entry decision, this estimation strategy is not computationally feasible.

I also propose an estimation strategy based on the total number of hospitals in the market. However, I base my strategy on the tuples $\left(N^{\star,\text{nfp}}, N^{\star,\text{fp}}\right)$, the total number of not-for-profit and for-profit entrants in all the equilibria of the game. As stated previously, these tuples are not unique and I need a way to overcome this problem. I propose an algorithm that solves for all the tuples $N^{\star,\text{nfp}}, N^{\star,\text{fp}}$ that correspond to all equilibria of the game. I deal with the multiplicity by using an equilibrium selection rule. My strategy is to pick an equilibrium from the set computed by the algorithm and estimate the model by simulated method of moments. This can be intuitively seen in figure 1. The strategy is to assign the white area to one of the two hospitals. Following this strategy in a simple 2×2 setting, Maximum Likelihood is computationally simple and feasible. The markets I study have 1201 potential entrants. By using the equilibrium selection rule, Maximum Likelihood is theoretically feasible, however it is computationally impractical. Since the simulated maximum likelihood is inconsistent, I use the simulated method of moments to estimate the model.

I use the cross sectional variation in markets to estimate, and identify the parameters of the model. Let $m = \{1, \cdots, M\}$ denote the markets. To simulate the model, I assign each potential entrant in every market a draw from the standard normal distribution. The payoff function for potential entrants in each market is given in equation 1.

I also assume that the unobservables for each hospital is different in every market i.e in each market, I draw a different random shock for the hospital. A note on identification is in order here. Throughout the exposition, I set the payoffs for the not-for-profit and for-profit hospitals from not entering the market to zero. Implicitly, I am assuming that $\tilde{\pi}^j_{i,m}$ is the difference between the payoffs from entering the market or staying out. Therefore β^j represents the difference between those parameters as well. So I only identify differences of the parameters but not their levels. However, the competitive parameters are identified through competition between entrants. Therefore, I identify the level of these parameters.

The estimation routine minimizes the distance between the observed and simulated values. Specifically, I simulate the number of for-profit and not-for-profit hospitals from the model. I take the average of these numbers across all markets, and compare them to the true average in the data. The criterion function for minimization is given by

$$\min_{\theta \in \Theta} \left(\frac{1}{M} \sum_m \widetilde{N_m^{\text{nfp}}}(\theta) - \frac{1}{M} \sum_m N_m^{\text{nfp}} \right)^2 + \left(\frac{1}{M} \sum_m \widetilde{N}_m^{\text{fp}}(\theta) - \frac{1}{M} \sum_m N_m^{\text{fp}} \right)^2 \tag{4}$$

Where $\widetilde{N_m^{\text{nfp}}}(\theta)$ is the average number of not-for-profit hospitals in market m corresponding to S simulations with a parameter vector θ. Similarly, $\widetilde{N_m^p}(\theta)$ is the simulated average for for-profit hospitals. θ is the parameter vector of interest. The optimization of (4) is similar to a generalized method of moment estimation. In fact it is exactly the Generalized Method of Moments (GMM) if we did not have to simulate the number of hospitals in each market[10]. To simulate the model, I first draw a random shock for every hospital in every market. These shocks will be drawn once and only once from a standard normal distribution, otherwise the parameter estimates will not be consistent (see Gourieroux and Monfort, 1995b, Chapter 2). From an initial parameter guess, I calculate the portion of the payoffs that does not include the competitive effect for all hospitals in a market, that is

$$\pi^j_{i,m} = X_m \beta^j - \epsilon^j_{i,m}$$

[10]Here the weighing matrix of the GMM is the identity matrix.

Once the above quantities are calculated, I order them in every market by type as

$$\pi^{\text{nfp}}_{(1)} > \pi^{\text{nfp}}_{(2)} > \pi^{\text{nfp}}_{(3)} > \pi^{\text{nfp}}_{(4)} > \cdots\cdots > \pi^{\text{nfp}}_{(\mathbb{N}^{\text{nfp}})},$$

and, (5)

$$\pi^{\text{fp}}_{(1)} > \pi^{\text{fp}}_{(2)} > \pi^{\text{fp}}_{(3)} > \pi^{\text{fp}}_{(4)} > \cdots\cdots > \pi^{\text{fp}}_{(\mathbb{N}^{\text{fp}})}.$$

Where $\pi^{j}_{(i)}$ denotes thej^{th} type hospital with the i^{th} highest payoff, i.e. the order statistics of the payoffs by type in each market. Once I obtain the ordering, I use an algorithm to find all the equilibria in every market. I then use an equilibrium selection rule to draw an equilibrium from the set of equilibria of the game. I repeat this S times for every market. I average these numbers over S simulations for every market, and get the average number of hospitals by type for all markets. Finally, I match these values to the actual values in the data.

The standard errors generated by this estimation routine are almost the ones generated by the GMM. The only difference is a minor change to reflect the fact that I am simulating the criterion function. To account for the simulation, I augment the GMM standard errors by a factor equal to the inverse of the number of simulations and arrive at the standard errors for the estimation above (see Gourieroux and Monfort, 1995b; Pakes and Pollard, 1989). I now propose the algorithm to find all the equilibria of the game.

3.1 The Algorithm

Assume a general model that does not predict a unique equilibrium. To see this, suppose the competitive effect is equal across and within types. As an example suppose the true competitive function is given by $f\left(\theta^{j}, N^{j}_{i}, N^{-j}\right) = -3N^{-i}$, where N^{-i} denotes the total number of hospitals in the market except for hospital i. Suppose there are 4 potential entrants in total, 2 of each type. Suppose after simulating the model for a given set of parameters and random shocks, I observe the following payoffs which do not include the competitive effects. $\pi^{\text{nfp}} = \{3{,}4\}$, and $\pi^{\text{fp}} = \{3.5{,}4.5\}$. The outside option from no entry for all hospitals is 0. This specific set of draws can have the following equilibria (2,0), (0,2), (1,1). Thus for the **same** unobservables vector I can attain three different equilibria. For example the two not-for-profit hospitals can enter since $\pi^{\text{nfp}} + f(\theta, N_i^j, N^{-j}) = \pi^{\text{nfp}} - 3N^{-i}$ are $3 - 3 \geq 0$, and $4 - 3 \geq 0$. In this market structure, no other hospital chooses to enter since the third most profitable hospital does not; $4.5 - 6 \leq 0$. Notice that whenever I hold fixed the number of hospitals of one type, only a unique equilibrium is possible. For example, suppose I look for an equilibrium where only one not-for-profit hospital enters, the only possible equilibrium I get is one not-for-profit , and one for-profit hospital. Thus, if I condition on the number of hospitals of one type, I can calculate a unique solution to the game[11]. I use this insight to form the algorithm.

The goal of the algorithm is to find all the tuples that correspond to all the PSNE of the game.

The steps of the algorithm are as follows:

1. Order the payoffs for each type as in equations 5.

2. Form a $(\mathbb{N}^{\text{nfp}} + 1) \times (\mathbb{N}^{\text{fp}} + 1)$ matrix that contains all zeros with row and column names 0 to $\mathbb{N}^{\text{nfp}}$, and 0 to $\mathbb{N}^{\text{fp}}$ where $\mathbb{N}^j$ is the number of potential entrants that are of type j.

3. For each row indexed by r in the matrix, enumerate the "possible equilibria" if any exist by changing the zero in the corresponding cell to a one. To do this solve for $\ell^\star$

   (i)
   $$\ell^\star = \max \left\{ \ell : \pi_{(r)}^{\text{nfp}} + f\left(\theta^{\text{nfp}}, r-1, \ell\right) \geq 0 \right\}$$

   This says to get the maximum number of for-profit hospitals that r not-for-profit hospitals can sustain. The idea comes from the following: if the not-for-profit hospital with the r^{th} highest payoffchooses not to enter a market structure with $\ell^\star$ for-profit , and $r-1$ not-for-profit hospitals, there cannot be an $(r, \ell^\star)$ equilibrium.

[11] This is true because I assume that competitive effects are continuously decreasing. However, with some minor modification the algorithm works for any bounded continuous function

This is true because all not-for-profit hospitals with lower payoff will also choose to stay out of the market when the r^{th} highest payoff hospital chooses to do so.

(ii) Now I need to check how many for-profit hospitals can sustain r not-for-profit hospitals as well as themselves. For this solve the following

$$c^{\star} = \max \left\{ c : \pi^{\text{fp}}_{(c)} + f\left(\theta^{\text{fp}}, r, c-1\right) \geq 0 \right\}$$

This is analogous to the previous discussion. $c^{\star}$ is the maximum number of for-profit hospitals that can sustain themselves as well as r not-for-profit hospitals. If $c^{\star} \leq \ell^{\star}$, enumerate the cell $(r, c^{\star})$ as a possible equilibrium by changing the zero in the cell into a 1. Note that if $c^{\star} > \ell^{\star}$, there cannot be an equilibrium $(c, \ell^{\star})$ since r not-for-profit hospitals can only sustain $\ell^{\star}$ for-profit hospitals but $c^{\star} > \ell^{\star}$ for-profit hospitals can sustain r not-for-profit hospitals.

(iii) Repeat this procedure for every row in the matrix. While iterating on every row, reset all the 1s' from previous iterations to 0s' that are to the north-west corner of any "possible equilibrium" of the current row. At row 1 indicating zero not-for-profit hospital skip step 3(i).

4. All the possible equilibria that are left are actual equilibria of the game. It is important to note that the algorithm is silent about the identity of rivals in the model.

Claim The Algorithm given above will always find all the equilibria in the model

Proof See the Appendix

I will go through the application of the algorithm for the example given in this section.

Step 1 Order the payoffs for each type

$$\pi^{\text{nfp}}_{(i)} = \{4,3\}$$
$$\pi^{\text{fp}}_{(i)} = \{4.5,3.5\}$$

Step 2 Form the matrix as in step 2. Let $\mathbf{N}^{\mathrm{nfp}}$, and $\mathbf{N}^{\mathrm{fp}}$ denote the number of for-profit , and not-for-profit hospitals respectively that enter the market in all equilibria.

$\mathbf{N}^{\mathrm{nfp}}$ \ $\mathbf{N}^{\mathrm{fp}}$	0	1	2
0	0	0	0
1	0	0	0
2	0	0	0

To clarify, I give the matrix of payoffs for the market structure arising from the matrix above.

$\mathbf{N}^{\mathrm{nfp}}$ \ $\mathbf{N}^{\mathrm{fp}}$	0	1	2
0	(0,0)	(0,4.5)	(0,.5)
1	(4,0)	(1,1.5)	(-2,-2.5)
2	(0,0)	(-3,-1.5)	(-6,-5.5)

This matrix has in its rows the payoffs for the not-for-profit hospital that has the highest *r* payoff with a market structure of *r* not-for-profit hospitals, and *c* for-profit hospitals. For example, row 3 column 1 is a market structure with 2 not-for-profit , and 0 for-profit hospitals. The not-for-profit with the second highest payoff is facing one more not-for-profit hospital and therefore its payoff is $3 - 3 = 0$. In row 3 column 2, I have 2 not-for-profit and 1 for-profit hospitals. The payoff for the not-for-profit hospital is $3 - (3 \times 2) = -3$, while the payoff for the for-profit hospital with the highest payoff is $4.5 - (2 \times 3) = -1.5$.

At row 1, I have zero not-for-profit hospitals. The maximum number of for-profit hospitals that can enter is 2 since the for-profit hospital with the second highest payoff is willing to enter. Thus change the zero to 1 in this box

$\mathbf{N}^{\text{fp}}$

		0	1	2
	0	0	0	1
$\mathbf{N}^{\text{nfp}}$	1	0	0	0
	2	0	0	0

At row 1, step 3(i) solves for 1 for-profit hospital that can be sustained by the not-for-profit hospital with the highest payoff. Step 3(ii), has 1 not-for-profit hospital in the market, and the most the economy can sustain is another for-profit hospital. The for-profit hospital with the second highest payoff is making -2.5 in a 3 hospitals market structure, and thus chooses not to enter. Thus enumerate cell (2,2) by 1. Since there are no "possible equilibria" to the north-west corner of this cell, I do not need to reset anything. Applying the same to row 3, I get the "possible equilibrium" in cell (3,1). The matrix becomes

$\mathbf{N}^{\text{fp}}$

		0	1	2
	0	0	0	1
$\mathbf{N}^{\text{nfp}}$	1	0	1	0
	2	1	0	0

I am now left with all the tuples that make all the PSNE of the game. Thus the equilibria tuples are (0,2), (1,1),and (2,0). I apply this algorithm to the hospital market and estimate the model. In the next section, I present the data I use to estimate the model.

4. Data

To estimate the model, I need cross-sectional variation of entry decisions into markets. I need data that gives me the total number of hospitals in each market according to their ownership type. I also need data on market characteristics. To get this information, I use two main sources of data. The **A**merican **H**ospital **A**ssociation (AHA) survey for the year 2000, and the **A**rea **R**esource **F**ile (ARF) for the year 2004. The AHA surveys and collects data from all hospitals in the United states. I use the AHA survey to identify the number of not-for-profit , for-profit , and public non-Federal hospitals in the market. The ARF is a cumulative national county-level health resources information system that contains information on market characteristics. I use the ARF to collect information on population size, number of hmos, median income, percentage of old, percentage of whites, percentage of blacks, and housing density.

I use the **H**ealth **S**ervice **A**rea boundaries developed in Makuc, Ingram, Kleinman, and Fledman (1991) as a unit of analysis for the market. These geographic boundaries are constructed to measure the market for health care based on Medicare patient data[12]. Makuc *et al.* (1991) use cluster analysis to group counties into 802 service areas. They find that for almost all service areas constructed, the majority of hospital stays by area residents occur within the service area. They also find that for almost 39% of all counties, the majority of hospital stays by county residents occur outside the county. Thus, HSAs are superior to counties for defining the market for health services.

There are in total 802 HSAs in the United States. I keep all HSAs that are not in Hawaii or Alaska. I only keep general medical surgical hospitals from the AHA with more than 50 beds. I remove all hospitals that are less than 50 beds because of specialization. I also remove all federal hospitals since they do not serve the general public. I now keep all HSAs that have a combined total of at most 5 not-for-profit and for-profit hospitals. This is done to keep away from larger HSAs thus higher uncertainty about market boundaries and spillover effects. I end up with 525 HSAs in the final data, with 219 for-profit and 982 not-for-profit hospitals.

The ARF file is given as counties rather than HSAs . HSAs are group of counties that are interdependent on their health services. I thus, aggregate the information in the ARF file into HSA areas and merge it with the AHA survey.

[12] Abraham *et al.* (2005) use an approach similar to that of Bresnahan and Reiss (1988, 1991) to identify their markets. They develop rules based on the size of the population in cities and census designated areas. They come up with some boundaries believed to be "isolated markets" for hospital care. However, after applying these rules they identify 613 markets with 33% (205) of their markets not having a single hospital. Thinking about the demand for health care for the people in these 205 markets, their definition seems too restrictive

A more detailed description and summary statistics can be found in the Appendix.

5. Results

5.1 Linear Model Results

I begin by reporting some results without imposing the structure of the model. To do this, I estimate linear models that relate the number of not-for-profit (for-profit) hospitals to the number of for-profit (not-for-profit) hospitals. In these models, I do not restrict the size of the market. I have 2 different specifications for each type. Specifications M1 and M3 (M2, and M4) in table 2 regress the number of not-for-profit (for-profit) hospitals on the number of for-profit (not-for-profit) hospitals together with other exogenous variables. The specifications in table 2 are the following

$$\text{M1:} \qquad N_m^{np} = \alpha^{\text{nfp}} + X_m\beta^{\text{nfp}} + \theta^{\text{nfp}} N_m^{\text{fp}} + \epsilon_m$$

$$\text{M2:} \qquad N_m^{\text{fp}} = \alpha^{\text{fp}} + X_m\beta^{\text{fp}} + \theta^{\text{fp}} N_m^{\text{nfp}} + \epsilon_m$$

$$\text{M3:} \qquad N_m^{\text{nfp}} = \alpha^{\text{nfp}} + X_m\beta^{\text{nfp}} + \sum_{i=1}^{5} \theta_i^{\text{nfp}}\, \mathbb{I}\left(N_m^{\text{fp}} = i\right) + \epsilon_m$$

$$\text{M4:} \qquad N_m^{\text{fp}} = \alpha^{\text{fp}} + X_m\beta^{\text{fp}} + \sum_{i=1}^{5} \theta_i^{\text{fp}}\, \mathbb{I}\left(N_m^{\text{nfp}} = i\right) + \epsilon_m$$

X_m, denotes the exogenous variables used in these regressions as well as in the structural model, and are found in table 1.

$\mathbb{I}\left(N_m^{\text{fp}} = i\right)$ for $i = \left(1,2,3,4,5\right)$ is an indicator function taking the value 1 when we observe i, $i < 5$ for-profit hospitals in market m. The last group, $i = 5$ is an indicator function for having at least five for-profit hospitals in the market. $\mathbb{I}\left(N_m^{\text{nfp}} = i\right)$ denotes the same dummy variables but for the number of not-for-profit hospitals in the market. ϵ_m are the market unobservables for the econometrician that is common knowledge to all hospitals.

Specification M1 (M2) do not allow for nonlinearities in the effect of the number of for-profit (not-for-profit) hospitals in the market. Specifications M3 (M4) are unrestricted and

Table 1. DESCRIPTION OF VARIABLES

Variable	Description	Mean	SD
pop	Population in 10,000s	18.19	16.2
hmo	Number of HMO in market	.22	.71
prop_old	Proportion with age >= 65	.14	.032
prop_black	Proportion of blacks	.089	.12
prop_white	Proportion of white	.88	.13
income	Median income in 10000s	3.5	.70
housing_density	Housing unit density per sq. mile	138.78	181.5
GOV	Number of non-federal Hospitals	.58	.91

allow for different coefficients for every level of for-profit (not-for-profit) hospitals that are present in the market.

Table 2 presents the coefficient estimates for the above specifications. In this table, I do not restrict the market size, and I use all the data I can match from both surveys. After I merge the ARF and AHA data, I have 738 markets that are ranging from monopoly markets to a market that has 122 hospitals.

The first two columns of table 2 provide the estimates from models M1 and M2. The effect of the numbers of both types of hospitals is negative and significant. The effect of the number of nonprofit hospitals on the number of for-profit hospitals is much lower than the effect of the for-profit on the not-for-profit hospitals (-.21, versus -1.04). In addition, non-federal hospitals have opposite effects on the numbers of for-profit and not-for-profit hospitals. This stays true after controlling for nonlinearities in column 3 and 4 of table 2. Income has a positive effect on the number of not-for-profit hospitals, and a negative effect on the number of for-profit hospitals (.829 versus -2.8). It seems that not-for-profit hospitals are drawn to wealthier areas and for-profit hospitals are drawn to poorer areas. However, once we account for nonlinearities, income becomes insignificant in explaining the number of not-for-profit hospitals. In order to account for state fixed effects, I am forced to delete any HSA that spans more than one state. I reestimate the model, and include state fixed effects in table 3. In general, the results from both tables agree.

Table 2. LINEAR MODELS Number of one type hospitals on the number of hospitals from the other type

Coef	M1	M2	M3	M4
Dep. Var	$\mathbf{N}^{nfp}$	$\mathbf{N}^{fp}$	$\mathbf{N}^{nfp}$	$\mathbf{N}^{fp}$
Intercept	0.07469 (1.216)	-1.196 (1.079)	0.07769 (1.184)	-1.537 (1.079)
pop	0.0615*** (0.001593)	0.02898*** (0.001407)	0.06192*** (0.001559)	0.02953*** (0.001398)
hmo	0.3199*** (0.06082)	-0.03287 (0.05342)	0.3921*** (0.06014)	-0.007834 (0.05315)
percentold	10.29*** (2.332)	1.604 (2.045)	10.71*** (2.288)	1.743 (2.027)
income	0.8285** (0.3903)	-2.788*** (0.3482)	0.3985 (0.3869)	-2.72*** (0.3446)
housingdensity	1.176e-05*** (1.339e-06)	-1.889e-06 (1.422e-06)	1.105e-05*** (1.312e-06)	-2.086e-06 (1.408e-06)
percentblack	-0.3053 (1.335)	1.901 (1.184)	-0.7361 (1.305)	2.044* (1.174)
percentwhite	-0.6868 (1.316)	1.203 (1.161)	-0.8122 (1.286)	1.332 (1.152)
GOV	-0.8028*** (0.067)	0.1953*** (0.06145)	-0.7725*** (0.06552)	0.2136*** (0.06179)
$\mathbf{N}^{fp}$	-1.043*** (0.07499)			
$\mathbf{N}^{nfp}$		-0.2166*** (0.05218)		
$\mathbb{I}(\mathbb{N}^{-dep} = 1)$			-0.8299*** (0.1898)	-0.06314 (0.1929)
$\mathbb{I}(\mathbb{N}^{-dep} = 2)$			-1.487*** (0.2854)	-0.1402 (0.2155)
$\mathbb{I}(\mathbb{N}^{-dep} = 3)$			-1.615*** (0.4337)	-0.06758 (0.2555)
$\mathbb{I}(\mathbb{N}^{-dep} = 4)$			-3.129*** (0.6431)	-0.06952 (0.3245)
$\mathbb{I}(\mathbb{N}^{-dep} \geq 5)$			-7.396*** (0.4909)	-1.351*** (0.2798)
Nobs	738	738	738	738
R^2	0.8676	0.5919	0.8755	0.6034
$\bar{R}^2$	0.8659	0.5869	0.8732	0.5962

Notes: The dependent variable is either the number of not-for-profit hospitals or the number of for-profit hospitals. $\mathbb{N}^{-dep}$ denotes the number of hospitals that are not of the same ownership form as the dependent variable. Numbers in parenthesis report standard errors. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 3. LINEAR MODELS Number of one type hospitals on the number of hospitals from the other type, including state fixed effects

Coef	M1	M2	M3	M4
Dep. Var	$\mathbf{N_{nfp}}$	$\mathbf{N_{fp}}$	$\mathbf{N_{nfp}}$	$\mathbf{N_{fp}}$
Intercept	0.7634 (2.166)	-1.996 (1.9)	0.5033 (2.077)	-2.727 (1.906)
pop	0.06112*** (0.001739)	0.02829*** (0.001495)	0.06135*** (0.00168)	0.02856*** (0.001488)
hmo	0.3285*** (0.06835)	0.0106 (0.05908)	0.4211*** (0.06661)	0.03785 (0.0591)
percentold	8.723*** (2.916)	0.6945 (2.537)	8.896*** (2.81)	0.9965 (2.523)
income	0.6208 (0.4232)	-2.421*** (0.3704)	0.09188 (0.4145)	-2.378*** (0.3678)
housingdensity	1.236e-05*** (1.695e-06)	-5.243e-06*** (1.73e-06)	1.147e-05*** (1.636e-06)	-5.104e-06*** (1.719e-06)
percentblack	-0.5946 (2.292)	0.2212 (1.994)	-0.5645 (2.2)	0.7169 (1.986)
percentwhite	-2.034 (2.089)	2.154 (1.822)	-1.777 (2.006)	2.466 (1.813)
GOV	-0.8691*** (0.07917)	0.1742** (0.07052)	-0.8164*** (0.07622)	0.1996*** (0.07179)
Profit	-0.9286*** (0.09466)			
Nprofit		-0.04449 (0.06315)		
$\mathbb{I}(\mathbb{N}^{-dep} = 1)$			-0.6359*** (0.2185)	0.1355 (0.203)
$\mathbb{I}(\mathbb{N}^{-dep} = 2)$			-1.102*** (0.3423)	0.2137 (0.2353)
$\mathbb{I}(\mathbb{N}^{-dep} = 3)$			-0.9064* (0.4936)	0.4051 (0.2949)
$\mathbb{I}(\mathbb{N}^{-dep} = 4)$			-2.262*** (0.6889)	0.5282 (0.3728)
$\mathbb{I}(\mathbb{N}^{-dep} \geq 5)$			-7.127*** (0.5636)	-0.5262 (0.3379)
Nobs	663	663	663	663
R^2	0.8879	0.6662	0.8978	0.6737
$\bar{R}^2$	0.878	0.6365	0.888	0.6423

Notes: The dependent variable is either the number of not-for-profit hospitals or the number of for-profit hospitals. $\mathbb{N}^{-dep}$ denotes the number of hospitals that are not of the same ownership form as the dependent variable. Numbers in parenthesis report standard errors. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

However, the results from these models should not be taken at face value as they are plagued with several problems. The most important problem is that of endogeneity. Hospitals locate in areas that have favorable characteristics that are not observed by the econometrician i.e. favorable ϵ_m. These characteristics are surely correlated with the covariates of the model, and any regression that does not account for this behavior, and instruments properly will suffer from biased and inconsistent estimates. Although, one might be able to find such instruments, I choose not to do so for two main reasons; First, I can argue that the two dependent variables must be simultaneously estimated. This is analogous to the supply and demand estimation problem, where price and quantity are determined simultaneously and we only observe equilibrium outcomes. Estimating the number of for-profit and number of not-for-profit hospitals simultaneously does not add any major econometric problem. However, to do so I require some exclusion restrictions (again instruments) in order to identify the parameters. There are no intuitive reasons why one should exclude one variable from one equation and not the other. Any variable that affect the decision of one ownership type will surely affect the decision of the other. Thus, any exclusion is deemed ad-hoc, therefore I do not follow this strategy. Second, this paper asks the question of whether or not for-profit or not-for-profit hospitals affect each other the same way they do their counterparts. To answer this question, I need to estimate a specification where I have the number of same type hospitals on the right hand side of the equation[13]. Using only a cross section of markets, a model like this cannot be estimated because the dependent variable appears on both sides of the equation. Thus, I need to impose some structure on the model in order to estimate the parameters of interest. I use the model described in section 2 to overcome the above difficulties. The following section discusses the results of the full model.

[13]This is a simplification since we still cannot interpret the coefficient of this system as a behavioral parameter

5.2 Full Model Results

I parameterize the hospitals' payoff functions according to their types as follows

$$\begin{aligned}\pi_{im}^{\text{nfp}} &= \theta_{\text{nfp}}^{\text{nfp}}\, N_m^{\text{nfp}} + \theta_{\text{fp}}^{\text{nfp}}\, N_m^{\text{fp}} + \gamma^{\text{nfp}}\, GOV_m + X_m\beta + \epsilon_{i,m}, \qquad i \in \{1, \cdots, \mathbb{N}^{\text{nfp}}\} \\ \pi_{jm}^{\text{fp}} &= \theta_{\text{fp}}^{\text{fp}}\, N_m^{\text{fp}} + \theta_{\text{nfp}}^{\text{fp}}\, N_m^{\text{nfp}} + \gamma^{\text{fp}}\, GOV_m + X_m\beta + \epsilon_{j,m}, \qquad j \in \{1, \cdots, \mathbb{N}^{\text{fp}}\}\end{aligned}$$

Where $\theta_{\text{nfp}}^{\text{nfp}}$ $(\theta_{\text{fp}}^{\text{fp}})$ is the effect of the not-for-profit (for-profit) hospital on its own type, and $\theta_{\text{fp}}^{\text{nfp}}$ $(\theta_{\text{nfp}}^{\text{fp}})$ is the effect of the for-profit (not-for-profit) on the not-for-profit (for-profit) hospital. $\gamma^{\text{nfp}}(\gamma^{\text{fp}})$ is the effect of public non-Federal hospital on the not-for-profit (for-profit) hospital. X is the matrix of covariates that is assumed to have common influence on both for-profit and not-for-profit hospitals. This matrix contains variates that are explained in table 1. I assume that hospitals make independent decisions in every market, and the number of potential entrants is equal to the sum of all hospitals that I observe in all markets. This leads to 1201 potential entrants in every market, 219 of which are for-profit and the rest are not-for-profit . I use 20 simulations for every hospital in each market and for every step in the optimization of the criterion function. For every hospital in each market, I draw the errors once and only once from a standard normal distribution. I do not redraw the errors in every step of the optimization in order to get consistent estimates (Gourieuroux MomFort 1996). The results of the full model are presented in tables 4, and 5.

As stated in the model, and econometric sections of the paper, I need to assume an equilibrium selection rule to force the model to predict a unique equilibrium. To estimate the model, I use two equilibrium selection rules. table 4, uses a "random selection" rule. After calculating all equilibria of the game, this rule picks one of these equilibria with equal probability. Table 5 uses a "maximum not-for-profit" rule. This rule chooses the equilibrium that has the largest number of not-for-profit amongst all the equilibria computed.

We see that both selection rules produce intuitive estimates. In the first column, under the random selection rule, the estimates predict the effect of other hospitals with the same type is much larger than that of the other type. For example the effect of the not-for-profit

Table 4. ENTRY MODEL. RANDOM SELECTION RULE

Coef	for-profit	not-for-profit
Own Type Effect	-8.65 (1.237)	-15.45 (2.134)
Other type effect	-3.465 (.986)	-7.697 (1.712)
Government effect	-13.683 (3.187)	-10.82 (.9534)
Population	11.80 (2.17809)	
HMO	(2.355) (1.7948)	
Percent Old	4.703 (.07627)	
Income	6.035 (2.7601)	
Housing Density	-9.816 (3.7813)	
Percent Black	12.051 (1.7390)	
Percent White	3.3267 (0.82702)	

Notes: These are the estimates of the profit functions of both for-profit and not-for-profit hospitals under the random selection rule Numbers in parenthesis report standard errors.

hospital on the for-profit hospital is less than half of the for-profit hospital on its own type. The same is true for the not-for-profit hospitals. The intensity of competition between not-for-profit hospitals is larger than that between for-profit hospitals(-15.45 versus -8.65). The effect of the not-for-profit on the for-profit hospital is less than half that of the for-profit on the not-for-profit hospital.

Non-federal hospitals have a larger effect on the for-profit hospitals. For-profit hospitals tend to stay away from areas where there are more non-federal government hospitals as opposed to their not-for-profit counterparts. This is at odds with the reduced form estimates. The income coefficient suggests that wealthier markets will have more hospitals of both types. As opposed to the reduced form estimates, it now has the correct sign. All other covariates have the expected signs.

Table 5. ENTRY MODEL. MAX NOT-FOR-PROFIT SELECTION RULE

Coef	for-profit	not-for-profit
Own Type Effect	-16.838	-13.37
	(2.587)	(2.391)
Other type effect	-4.315	-28.08
	(1.2110)	(5.027)
Government effect	-7.914	-21.393
	(2.024)	(3.1920)
Population	11.044	
	(1.8306)	
HMO	0.0207	
	(0.00592)	
Percent Old	6.6247	
	(1.6490)	
Income	9.650	
	(1.932868)	
Housing Density	-6.633	
	(1.646282)	
Percent Black	7.246	
	(1.351843)	
Percent White	1.551	
	(0.002446)	

Notes: These are the estimates of the profit functions of both for-profit and not-for-profit hospitals under the equilibrium selection rule that gives the largest number of not-for-profit hospitals. Numbers in parenthesis report standard errors.

Table 5 gives the estimate from the rule that selects the highest number of not-for-profit hospitals amongst all the equilibria computed. Although the differentiation story is still evident for for-profit hospitals, it now no longer works for not-for-profit hospitals. The effect of a for-profit hospital on a not-for-profit hospital is more than double the effect of the not-for-profit hospital on its own type (-28.1, versus -13.33). The for-profit hospital still has a larger effect on the not-for-profit hospital than that of a not-for-profit on a for-profit hospital. While the effect of the not-for-profit hospital on a for-profit counterpart is 22% larger in this selection rule, the for-profit effect on the not-for-profit hospital is almost 300% larger. Not only is the effect of public non-Federal hospitals now larger on not-for-profit hospitals, but it is also smaller on for-profit hospitals.

The qualitative as well as the quantitative results from the two selection rules are quite different. This suggests that equilibrium selection rules play an important role in any public policy based on this model. We need a way for the data to tell us which of these equilibrium selection rules is more plausible. To do this, I am currently working on a way to estimate the model where no equilibrium selection rules are required. These types of models do not provide point estimates but rather provide intervals for the parameters of interest. Once these boundaries are derived we can see which of the equilibrium selection rules performs better. This is done by checking which estimates fall within the boundary of the sets computed with the above strategy.

5.3 predictions of the model

On average, the data has .37 for-profit and 1.62 not-for-profit hospitals. Under the random selection rule, the model predicts an average market structure of .37 for-profit and 1.67 not-for-profit hospitals. Under the maximum not-for-profit selection rule, it predicts .44 for-profit and 1.63 not-for-profit hospitals. Thus, the model performs quite well using the two selection rules. To explore the economic significance of the competitive effects, I simulate the market assuming a perfect competition model. Here, I set all the competitive coefficients except for the effect of public hospitals to zero. I use the random selection rule to simulate the model. The model predicts an average of 10.7 for-profit and 46.4 not-for-profit hospitals. These averages are so far away from the true averages in the data, and I am confident that the competitive effects estimated by the model are not only statistically significant but are also economically significant.

In order to evaluate the economic significance of the other parameters, I simulate the effect of a 5% increase in one of the variables holding all other variables at the same levels. This is shown in table 6. Population has a significant impact on both for-profit and not-for-profit hospitals. A 5% increase in population leads to an increase of 15% and a decrease of 35% of for-profit and not-for-profit hospitals respectively.

One other advantage of putting structure on this model is its ability to conduct counter-

Table 6. PREDICTIONS OF THE MODEL

Variable	% change in not-for-profit	% change in for-profit
Population	-35.15	15.94
Income	.0258	.097
percentold	0	0

Notes: These are the predictions of the model from a 5% increase in the variables.

factuals. One of the most important counterfactual that governments are interested in, is the market structure resulting from only allowing one type of hospitals to operate in the market. I do this using the random selection mechanism estimates.

First, I consider a market where for-profit hospitals are not allowed to enter the market. Under such scenario, the model predicts an average number of 1.211 not-for-profit hospitals. Thus a decrease in the provision of health care services.

Second, I consider a market where every hospital has to pay taxes, therefore eliminating not-for-profit hospitals. In this setting, the model predicts an average number of 1.005 hospitals in the market.

Therefore, the model predicts a reduction in the provision of health care services when conducting the counterfactuals for both extreme policies. The model suggests that mixed markets have higher levels of health care services. This is an important finding and one that has not been pointed to in the existing literature.

6. Conclusion

In this paper, I examine the relationship between how hospital ownership is organized and the intensity of competition in the health care market. I build a game theoretic entry model where not-for-profit and for-profit firms first choose to enter the market, and second compete for the delivery of health care services. The model produces multiple equilibria in the number of for-profit and not-for-profit firms. To overcome the problem of multiple equilibria, I develop a simple and novel algorithm that computes all equilibria of the game. I use this algorithm together with two equilibrium selection rules to estimate the model.

I conclude that for-profit and not-for-profit hospitals are differentiated. The nature of competition amongst not-for-profit hospitals is more stringent than the nature of competition amongst for-profit hospitals. Comparing the competition between these two types of hospitals, for-profit hospitals have larger effects on not-for-profit compared to the effects of not-for-profit on for-profit hospitals.

I simulate two counterfactuals. First, I study a market were only not-for-profit firms exists. The results suggest a decrease in the level of health services. Second, I study a market were not-for-profit firms do not enjoy any tax shelters. I again find a decrease in the level of health services. I conclude that consumers value mixed ownership markets.

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Appendix .1 Proof of existence of equilibrium

To prove an equilibrium exists, let $\pi_i^j = X_m^j \beta^j + \epsilon_i^j$ denote the part of the payoffs that does not include the competitive effect. I prove the existence of an equilibrium by constructing an algorithm that can always find a solution to the model.

Appendix .1.1 Algorithm for existence

step 1 Order the firms within each type according to the portion of the payoffs that does not involve the competitive effects $f(\cdot)$. Let $\pi_{(l)}^j$ be the firm with the $l^t h$ highest payoff amongst all j type firms. Thus, we will have two orderings, one for the not-for-profit and one for the for-profit hospitals.

$$\pi^{\text{nfp}}_{(1)} \;>\; \pi^{\text{nfp}}_{(2)} \;>\; \pi^{\text{nfp}}_{(3)} \;>\; \pi^{\text{nfp}}_{(4)} \;>\; \cdots\cdots > \pi^{\text{nfp}}_{(\mathbb{N}^{\text{nfp}})} \tag{A 1}$$

$$\pi^{\text{fp}}_{(1)} \;>\; \pi^{\text{fp}}_{(2)} \;>\; \pi^{\text{fp}}_{(3)} \;>\; \pi^{\text{fp}}_{(4)} \;>\; \cdots\cdots \;>\; \pi^{\text{fp}}_{(\mathbb{N}^{\text{fp}})} \tag{A 2}$$

step 2 Solve for the maximum number of not-for-profit firms that can coexist with each others without any of their for-profit counterparts. That is find ξ such that

$$\xi^{\star} = \max_{\xi} \left\{ \xi : \pi^{np}_{(\xi)} + f\left(\theta^{np}, \xi - 1, 0\right) \geq 0 \right\}$$

The idea stems from the fact that there won't be any equilibrium with $\xi^{\star}$ not-for-profit firms and 0 for-profit firms if the not-for-profit firm with the $\xi^{\star}$ highest payoff does not wish to enter the market.

step 3 Given $\xi^{\star}$, the number of not-for-profit firms, check to see how many for-profit firms wish to enter by solving the following

$$\eta^{\star} = \max_{\eta} \left\{ \eta : \pi^{p}_{(\eta)} + f\left(\theta^{p}, \eta - 1, \xi^{\star}\right) \geq 0 \right\}$$

step 4 Given $\eta^{\star}$, check whether $\xi^{\star}$ not-for-profit firms are still feasible. If $\xi^{\star}$ are feasible, stop. If not repeat **step 2** but instead of zero for-profit firms we now have $\eta^{\star}$ of them. Once a new value for $\xi^{\star}$ is computed repeat **step 3**. Continue iterating **step 2** and **step 3** until a tuple is established where only the firms with the highest $\xi^{\star}$, and $\eta^{\star}$ payoffs of the respective type will wish to enter.

To form the equilibrium for the above tuple, and show that it satisfies the equilibrium strategies in 2, and 3, assign 1s to 1 to $\eta^{\star}$, and 1 to $\xi^{\star}$ highest for-profit , and not-for-profit payoff firms, and zeros to the rest of both types. By construction, these strategies must satisfy the equilibrium in 2, and 3.

Because $f(\cdot,\!.\cdot)$ is continuously decreasing, a tuple $(\xi^{\star}, \eta^{\star})$ can always be found. Indeed, one can find such a tuple in at most $2 \times (k+1)$ moves, where k is equal to the first $\xi^{\star}$ solved for in **step 1**. However, the model does not predict a unique equilibrium in the identity of entrants. To see this, one only has to look at the equilibrium constructed above and check whether the firms with $\xi^\star + 1$, or $\eta^\star + 1$ payoff would be willing to change spots with the $\xi^\star$, or $\eta^\star$ highest payoff firms. Such an equilibrium will result in the same number of firms but with different identities. In addition, the model does not predict a unique equilibrium in the number of firms of each type. To see this, one can imagine that both $(\xi^\star, \eta^\star)$, and $(\xi^\star - 1, \eta^\star + 1)$ are equilibria in the number of firms for the game. An example was given in the econometric section that demonstrates this point.

Appendix .1.2 Proof of Algorithm

Proof Suppose there exists an equilibrium that is not found by the algorithm above, call it (r, c). There are two possibilities for the algorithm failing to enumerate this equilibrium.

1. At row r, cell (r,c) was not replaced by a one in step (3) of the algorithm. Either step 3(i) or 3(ii) failed to enumerate this cell.

   (a)
$$c \neq \ell^\star = \max\left\{\ell : \pi^{\text{nfp}}_{(r)} + f\left(\theta^{\text{nfp}}, r-1, \ell\right) \geq 0\right\}$$

   It must be that either $c > \ell^\star$, or $c < \ell^\star$

   i. Suppose $c < \ell^\star$

$$\pi^{\text{nfp}}_{(r)} + f\left(\theta^{\text{nfp}}, r-1, \ell^\star\right) < 0 \Rightarrow \pi^{\text{nfp}}_{(<r)} + f\left(\theta^{\text{nfp}}, r-1, \ell^\star\right) < 0$$

   where, $\pi^{\text{nfp}}_{(<r)}$ denotes any not-for-profit firm with smaller payoff than that of the r^{th} highest not-for-profit payoff firm. Therefore, (r,c) cannot be an equilibrium since there is no combination of r not-for-profit firms that can sustain c for-profit firms.

   ii. Suppose that $c < \ell^\star$

   This means that although r not-for-profit firms can coexist with $\ell^\star > c$ for-profit firms, only $\ell^\star$ for-profit firms can coexist with c not-for-profit firms.

Again, (r,c) cannot be an equilibrium. Thus the equilibrium must have failed to enumerate the cell in step 3(ii).

(b)

$$r \neq \eta^{\star} = \max\left\{\eta : \pi^{\text{fp}}_{(\eta)} + f\left(\theta^{\text{fp}}, c, \eta - 1\right) \geq 0\right\}$$

The same logic as above can be applied to assert that if (r,c) is an equilibrium, step 3 of the algorithm must have enumerated it as a "possible equilibrium". If more than c for-profit can afford themselves as well as r not-for-profit firms, this implies that (c, r) cannot be an equilibrium because at least the for-profit firm with the $(c+1)$ highest payoff wants to enter the market. If instead less than c for-profit firms can afford themselves as well as r not-for-profit firms, similar logic as above implies that there are no combination of other firms that will be in an (c, r) equilibrium. Therefore, it must be the case that (r, c) was enumerated as a "possible equilibrium" in step 3. Thus the algorithm must have changed the enumeration of "possible equilibrium" into no equilibrium in step 3(iii).

2. Cell (r, c) was marked with a one but was annihilated in step 3 (iii) of the algorithm. If so, (r, c) cannot be an equilibrium since another"possible equilibrium" in the south east corner of (r, c) exists. This means that at least the $r^{th} + 1$ highest not-for-profit payoff firm wants to enter the market when there are (r,c) not-for-profit and for-profit firms.

Therefore, the algorithm will find all the tuples that correspond to all the equilibria of the game.

Appendix .2 Data Description

In this appendix, I will describe in more details the data I have used. The two sets of data that I have used are the **A**merican **H**ospital **A**ssociation survey for the year 2000, and the **A**rea **R**esource **F**ile for the year 2004. The **AHA** survey is a yearly survey that collects data on over 6000 hospitals in the **US**. This data contains elements on organizational structure, facilities and services, utilization data, community orientation indicators, physician arrangements, managed care relationships, expenses and staffing. The **ARF** is a national county-level health resources information system that contains information on health professions, health training programs, health facilities, measures of resource scarcity, and health status. It also contains specific geographic codes and descriptors and information on economic activity, and socioeconomic and environmental characteristics. these files are cumulative and more recent data are not dropped. Thus the 2004 version has the year 2000 data as well.

There are 802 **H**ealth **S**ervice **A**reas in the US. However, some of the areas in Virginia do not correspond to an HSA . Because of this, 35 hospitals cannot be associated with any market in my analysis, so they are dropped. I merge the AHA survey with the ARF survey to conduct the analysis. I do so by matching states and counties from both files. After this, I aggregate all variables that I need for estimation into HSAs . Some of these variables are given in medians. For these variables, I take the mean over all medians for all counties that belong to the same HSA .

Originally, I start with 6044 hospitals made up of 3222 not-for-profit organizations, 1095 for-profit organizations, 249 Federal Hospitals, and 1478 public non-Federal ones. Because I drop Hawaii, Alaska, and the Associated Areas, I end up with 5923 hospitals, after which I drop all Federal hospitals and am left with 5685 hospitals. I drop Federal hospitals because these organizations do not admit the general public, and are made up of Air Force, Army, Navy, Department of Justice, and other Federal entities. Furthermore, I drop all specialized hospitals, and only concentrate on those that are general medical and surgical units with more than 50 beds. Since I do not study the decision of the public sector and take the locations of non-Federal hospitals as exogenous, I end up with 1201 for-profit , and not-for-profit hospitals, and 525 markets.

These 1201 hospitals are made up of 982 not-for-profit , and 219 for-profit organizations. Out of 525 markets, 52 of them are totally dominated by for-profit firms. These 52 markets are organized as follow: 38 monopoly, 9 duopoly, 3 triopoly, and there is one market with 4 firms, one with 5. Table 7 below gives this summary as well as the average population size per market structure.

There are 373 markets that are dominated by not-for-profit hospitals. These markets are divided into 155 monopolies, 104 duopolies, and 59 triopolies. 25 and 30 markets have 4 and 5 not-for-profit hospitals respectively. Table 7 below gives this summary as well as the average population size per market structure.

This leaves us with 100 markets that are mixed. Of these, we have 26 duopolies, and 30 triopolies. 25, and 19 markets have 4 and 5 mixed firms respectively. Table 9 shows the distribution of these markets, together with the average population size. This table also shows the average number of for-profit and not-for-profit firms for each market structure.

Table 7. Distribution of for-profit dominated markets

market structure	number of markets	mean population (in 10,000s)
1	38	11.07972
2	9	10.63311
3	3	21.02903
4	1	51.81320
5	1	68.60080

Table 8. Distribution of not-for-profit dominated markets

market structure	number of markets	mean population (in 10,000s)
1	155	8.052546
2	104	13.566848
3	59	21.535002
4	25	29.888584
5	30	43.135553

Table 9. Distribution of mixed markets

market structure	nº. markets	mean nº. for-profit	mean nº. not-for-profit	mean population (in 10,000s)
2	26	1.000000	1.000000	20.08362
3	30	1.433333	1.566667	24.64571
4	25	1.600000	2.400000	30.88549
5	19	1.894737	3.105263	44.43604