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Abstract

Not-for-profit hospitals are argued to differ little from their for-profit counterparts in the provision of care yet they enjoy tax-exempt status and face almost no requirements. In this work, I estimate the valuations hospitals assign to service provision relative to the value they assign to profits by hospital ownership, (for-profit, not-for-profit or government owned) in a structural way and present evidence that valuations differ significantly by ownership type. Despite the absence of requirements, not-for-profit hospitals value services relative to profits much more than their for-profit counterparts. The estimates are obtained by comparing the profits hospitals would have made had they provided the service and the costs had they not provided the service to what was actually done, which is calculated using demand models.

Keywords: hospital ownership type, service provision

JEL classification: I11, L20, L33

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1 Introduction

Not-for-profit hospitals are argued to differ little from their for-profit counterparts in the provision of care yet they enjoy tax-exempt status and face almost no requirements. Previous research on ownership of hospitals has largely focused on financial measures such as costs, profits and responsiveness to financial pressure and it has been traditionally concluded that there are few differences between for-profits and not-for-profits (Duggan 2000, Sloan et al. 2001, Picone et al. 2002, Shen et al. 2005). Malani and Choi (2004) also claimed that there is no difference in objectives by ownership type and empirical studies have found little difference in adoption of technology (Sloan et al. 2001) and exercise of market power (Gaynor and Haas-Wilson, 1999). There is very little literature on differences between hospitals on dimensions other than financial measures such as service provision. Horwitz (2005), and Horwitz and Nichols (2009), found that for-profit hospitals are more likely than not-for-profit hospitals to provide profitable services and government hospitals have the lowest probability of offering profitable services, whereas for-profits are the least likely and government hospitals are the most likely to offer unprofitable services. Bayindir (2012) investigated how hospital ownership type affects treatment choices and found that not-for-profit hospitals significantly differ from for-profits in terms of treatment choices of less profitable patients and not-for-profit hospitals seem to lie between for-profit and government hospitals in terms of profit-seeking behavior. However, a structural model has not been used to test the differences in any dimension between hospitals by ownership type.

The main assumption of hospital ownership theories is for-profit hospitals are expected profit maximizers. For-profit hospitals are more likely to respond to incentives compared to not-for-profit and government hospitals (Danzon 1982) and they upcode to generate higher reimbursements (Silverman and Skinner 2000). Frank and Salkever (2000) also show that for-profit hospital margins were greater than government and not-for-profit hospital margins during 1990s.

Although not-for-profit hospitals are privately owned, just like for-profit hospitals, they are claimed to be more likely to adopt public goals such as maximizing quantity and quality over profits (Newhouse 1970) or responding differently to market failures (Salamon 1987, Weisbrod 1988) in serving the needy. Managerial behavior also may be different among hospitals of different ownership types. Not-for-profit hospitals may be attracting special kinds of people such as managers with particularly altruistic goals (Rose-Ackerman 1996).

In this paper, I test several not-for-profit hospital theories by investigating the differences between hospitals by ownership type on values assigned to service provision relative to profits in a structural way. The first not-for-profit hospital theory I consider is that not-for-profits maximize own output, which is some weighted average of various measures of quantity and quality of care supplied by the hospital and profits (Newhouse 1970). According to this theory, not-for-profits only care about the patients treated in their hospital instead of the welfare of all of the patients in the market in addition to profits. Therefore instead of selecting procedures to provide what the market needs, not-for-profits make selections to increase a weighted average of value they assign to quality (considered as service provision in this work) and profits. The second not-for-profit theory I consider is that not-for-profits are for-profits in disguise, a theory developed by Pauly and Redisch (1973). According to this theory, not-for-profits and for-profits are the same, and they are both maximizing their expected profits. If all not-for-profits are for-profits in disguise, the values not-for-profits assign to service provision relative to profits should not be different from the values assigned by for-profits. The third theory I consider is the total market output maximization theory by Weisbrod (1988). According to this theory not-for-profits may offer more profitable treatments to generate more revenue to be able to afford increasing less profitable treatments or to serve unprofitable patients (uninsured) if they are total market output maximizers. The last theory is mixture theory (Hirth (1997; 1999)); some not-for-profits do not have the objective of maximizing profits, therefore they are true not-for-profits whereas some of them are for-profits in disguise.

To test these theories, the profits hospitals would have made had they provided the service and the costs had they not provided the service is compared to what was actually done. Calculating the profits of hospitals in the hypothetical cases requires deriving an estimate of patient demand for hospitals. The analysis is conducted in two steps. First, I estimate a discrete choice model of demand for hospitals, taking into account patient characteristics such as location, diagnosis and insurance type. The second step is to use the estimated parameters from this demand system to find hospital demand and profits had they provided an additional service or had they not provided a service that is currently provided and estimate the values hospitals assign to service provision relative to profits using the fact that hospital's service availability choice should be the one that maximizes its objective function.

My demand analysis is closely related to Town and Vistnes (2001), Capps, Dranove and Satterthwaite (2003) and Ho (2006). All of these papers use logit demand models to estimate consumer preferences over hospitals. The strategy set out in Pakes et al. (2015) is used to estimate the values hospitals assign to service provision relative to profits.

The paper continues as follows. In the next section I describe the relevant aspects of the industry. Section 3 describes the dataset. The estimation procedure is explained in Section 4. Estimation results are given in Section 5 and Section 6 concludes.

2 Industry Background and Assumptions

The persistent mix of ownership types in the hospital industry has generated considerable interest. Slightly less than two-thirds of US general hospitals in urban areas are private not-for-profit, with roughly equal number of for-profits and government hospitals; about half of general hospitals in rural areas are not-for-profit and about 40 percent are government hospitals. Shares of hospitals by ownership type have been relatively stable despite active hospital market consolidation especially during the late 1990s (Abraham, Gaynor and Vogt 2005). In my model, hospitals first choose the services they will provide and then patients choose hospitals depending on hospital and patient characteristics. I do not model the ownership type decision of hospitals since location and ownership type choices are potentially made simultaneously and are longer run decisions than service provision.

In my analysis, a market is defined as a Hospital Referral Region (HRR), which represents regional health care markets for tertiary medical care as defined by the Dartmouth Atlas of Healthcare. There are 306 HRRs in the U.S.

When estimating the values hospitals assign to service provision relative to profits, the average profitability of a patient given diagnosis is assumed to just depend on insurance type. Average profitability of patients by insurance type is obtained from American Hospital Association (AHA) survey. So, hospitals decide to provide a service considering the insurance type of the patient pool they will attract have they decided to provide the service. Only marginal cost of providing the service is considered in the model, all other costs associated with the provision of the service such as costs of equipment and building are assumed to be sunk. Moreover, when calculating the profits hospital would have made if an additional service was provided, the hospital is assumed to meet all of the additional demand and other hospitals' service selections are not allowed to change when doing the counterfactual. Furthermore I focus on inpatient care. According to the AHA, 65 percent of hospital revenues in 2001 were derived from inpatient care and the remainder came from outpatient services.

3 Data

My analysis employs two data sets. The first, State Inpatient Databases (SID) from 2004-2005, which covers nine states, 66 markets and 1325 hospital-years in the sample, includes the patient characteristics needed to estimate the consumer utility equation for hospitals. SID is an all-payer inpatient care database in the United States. It contains all discharge data from participating states. See Table 1 for list of states and number of hospital-years in the sample. General medical and surgical hospitals are used in the analysis. Hospital characteristics of all hospitals in each market are obtained from the second dataset, American Hospital Association Annual Survey.

Table 1: Distribution of markets and hospital-years by state.

State	Number of markets	Number of hospital-years
AR	5	140
AZ	4	84
FL	18	252
IA	8	180
NJ	6	102
NY	10	236
RI	1	17

WA	6	125
WI	8	189
Total	66	1325

For each admission, the data includes patient diagnosis and characteristics, insurance type and the identity of the hospital. Insurance type and major diagnostic category distributions are reported in Table 2. 40.8 percent of patients are Medicare patients and 35.17 percent of patients are privately insured. The most common diagnoses are circulatory system (17.86 percent of encounters) and pregnancy, childbirth (11.48 percent of encounters). Table 3 sets out summary statistics for the AHA and SID data sets. Hospitals in the sample have 211.03 beds and 1.24 registered nurses per bed on average; 10 percent are teaching hospitals.

Table 2: Number of patients by insurance type and Major Diagnostic Category

	All hospitals		Big hospitals	
	Frequency	Percent	Frequency	Percent
Medicare	4,526,597	40.8	3,411,217	39.24
Medicaid	2,044,444	18.43	1,653,471	19.02
Private	3,901,899	35.17	3,138,170	36.1
Uninsured	621,910	4.89	490,062	5.64
Nervous System	627,111	5.65	503,135	5.79
Respiratory System	1,058,689	9.54	774,142	8.90
Circulatory System	1,982,199	17.86	1,578,786	18.16
Digestive System	1,030,553	9.29	775,273	8.92
Hepatobiliary System	305,927	2.76	229,687	2.64
Musculoskeletal System	843,154	7.60	650,203	7.48
Skin, Subcutaneous Tissue	261,819	2.36	201,535	2.32
Endocrine	353,594	3.19	270,324	3.11
Kidney And Urinary Tract	419,843	3.78	324,969	3.74
Female Reproductive System	250,188	2.25	194,663	2.24
Pregnancy, Childbirth	1,273,447	11.48	1,029,506	11.84
Newborn	1,172,662	10.57	946,033	10.88
Mental Diseases	341,485	3.08	284,970	3.28
Alcohol/Drug Use	144,478	1.30	110,078	1.27
Burn	6,924	0.06	6,330	0.07
Other Diagnosis	1,025,311	9.24	815,186	9.38
Total	11,097,385		8,694,819	

Table 3: Descriptive statistics for Hospitals, AHA and SID dataset.

	All hospitals				Big hospitals			
	AHA dataset		SID dataset		AHA dataset		SID dataset	
	Mean	Std. Dev.	Mean	Std. Dev	Mean	Std. Dev.	Mean	Std. Dev
Number of beds	155.81	176.46	211.03	223.14	381.49	206.81	403.38	244.90
Teaching status	0.05	0.22	0.10	0.29	0.18	0.39	0.23	0.42
Registered nurses per bed	1.08	0.67	1.24	0.60	1.31	0.64	1.35	0.53
Not-for-profit hospital	0.53	0.50	0.69	0.46	0.69	0.46	0.80	0.40
For-profit hospital	0.23	0.42	0.12	0.33	0.12	0.32	0.09	0.29
Government hospital	0.24	0.43	0.19	0.39	0.19	0.39	0.11	0.31
Obstetrics	0.59	0.49	0.72	0.45	0.82	0.38	0.85	0.36
Cardiac intensive care unit	0.31	0.46	0.48	0.50	0.68	0.47	0.74	0.44
Neonatal intensive care unit	0.20	0.40	0.26	0.44	0.53	0.50	0.53	0.50
Burn unit	0.05	0.21	0.06	0.23	0.11	0.31	0.11	0.31
Alcohol unit	0.10	0.31	0.17	0.38	0.19	0.39	0.24	0.43
ESWL	0.22	0.41	0.29	0.46	0.43	0.50	0.45	0.50
Psychiatric emergency	0.32	0.47	0.41	0.49	0.63	0.48	0.69	0.46
Diagnostic radioisotope facility	0.54	0.50	0.69	0.46	0.84	0.36	0.90	0.30
MRI	0.55	0.50	0.66	0.47	0.81	0.39	0.82	0.39
PET scan	0.15	0.36	0.20	0.40	0.38	0.49	0.39	0.49
Cardiac Surgery	0.21	0.41	0.26	0.44	0.62	0.49	0.54	0.50
Number of observations	11,950		1,325		3,125		530	

Number and fraction of services provided by ownership type are reported in Table 4 for all hospitals and big hospitals (hospitals with more than 200 beds). A larger fraction of big hospitals provides all services compared to all hospitals. Services are grouped as unprofitable and profitable based on Horwitz (2005). Horwitz groups services as relatively profitable, relatively unprofitable or variably profitable using reviews of academic literature, policy reports and interviews with relevant experts. For example psychiatric emergency services are classified as unprofitable mainly because they attract a poorly insured, very sick population and psychiatric care reimbursement is uncertain and often low relative to cost whereas cardiac services are classified as profitable since they attract a well insured (mostly Medicare) population. In general surgical and diagnostic imaging services are high cost and high profit services (Horwitz 2005). Higher fraction of not-for-profits provides services; and the difference is higher for unprofitable services. On the average 37.7 percent of not-for-profits and 22 percent of for-profits provide unprofitable services, whereas a higher fraction of for-profits provides some of the profitable services such as cardiac surgery and MRI when all hospitals are considered and cardiac related services and diagnostic radioisotope facility when only big hospitals are considered. A much higher fraction of big hospitals provide high fixed cost services such as cardiac and diagnostic imaging services. PET scan is among the most costly and profitable diagnostic imaging services. Because of high fixed costs, only 13 percent of for-profit hospitals provide this service whereas 25 percent of big for-profit hospitals provide PET scan. 28 percent of not-for-profit and 34 percent of for-profit hospitals provide cardiac surgery, a high cost service, whereas 52 percent and 75 percent of big not-for-profit and for-profit hospitals provide it respectively.

Table 4: Number of hospital-years providing services.

	All Hospitals						Big Hospitals					
	Not-for-profit		For-profit		Government		Not-for-profit		For-profit		Government	
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Unprofitable services												
Alcohol unit	194	21	15	9	20	8	107	25	10	21	11	20
Burn unit	58	6	4	2	15	6	41	10	3	6	12	21
Obstetrics	706	77	85	52	167	68	374	88	25	52	50	89
Psychiatric emergency	427	47	41	25	82	33	301	71	22	46	42	75
Average unprofitable service	346.3	37.7	36.3	22.0	71.0	28.9	205.8	48.3	15.0	31.3	28.8	51.3
Profitable services												
Cardiac intensive care unit	496	54	68	41	73	30	309	73	37	77	43	77
Cardiac Surgery	261	28	56	34	29	12	221	52	36	75	29	52
Diagnostic radioisotope facility	693	75	119	72	106	43	386	91	44	92	49	88
ESWL	310	34	37	22	43	17	190	45	14	29	33	59
MRI	637	69	120	73	126	51	347	81	38	79	49	88
Neonatal intensive care unit	264	29	31	19	48	20	226	53	14	29	39	70
PET scan	217	24	21	13	30	12	168	39	12	25	25	45
Average profitable service	411.1	44.8	64.6	39.1	65.0	26.4	263.9	61.9	27.9	58.0	38.1	68.1
Total	918		165		246		426		48		56	

4 Estimation

My main objective in estimating demand is to understand to what extent consumer utility is affected by the set of services provided by each hospital in the market. First, demand for hospitals is estimated using a multinomial logit model following McFadden (1973) and Berry, Levinsohn and Pakes (2004), and allowing for observed differences across individuals.

With some probability consumer *i* becomes ill at time *t* in market *m*. His utility from visiting hospital h is given by

$$u_{iht} = u\left(x_{ht}, \frac{\nu_i}{\alpha}, \beta\right)$$

$$u_{iht} = \alpha x_{ht} + \beta x_{ht}\nu_i + \epsilon_{iht}$$

where x_{ht} are vector of observed hospital characteristics such as teaching status of the hospital, number of nurses per bed and service availability dummies (whether the hospital provides an alcohol unit, psychiatric emergency services etc.), ν_i are observed characteristics of the patient such as diagnosis, insurance type and location, and (α, β) are the coefficients on the specification. No market subscript and diagnosis subscript is needed on individual specific variables since patient characteristics include location and diagnosis. Subscript *t* defines years. Observed hospital characteristics are permitted to vary by year. Time subscript is omitted for the remainder of the paper for ease of exposition. No outside option is needed in the hospital choice equation: the data include only patients sick enough to go to hospital for a particular diagnosis. ϵ_{iht} captures unobserved idiosyncratic tastes which are assumed to be i.i.d. according to a Type 1 extreme value distribution.

Patients choose hospitals to maximize their utility, so that if consumer i (defined by major diagnostic category, insurance type and location) chooses hospital h then for all other hospitals h' in the market

$$u_{ih} = u(x_h, \nu_i/\alpha, \beta) \geq u_{ih'} = u(x_{h'}, \nu_i/\alpha, \beta)$$

This maximization produces the set A_h of ν that choose hospital h. Thus shares are given by:

$$s_h(x, \alpha, \beta) = Pr(\nu \in A_h)$$

This formulation implies that the share equation can be written as:

$$s_h = \sum_i \frac{N_i}{N} \left(\frac{\exp(\alpha x_h + \beta x_h \nu_i)}{\sum_{k \in H} \exp(\alpha x_k + \beta x_k \nu_i)} \right)$$

where N_i is the number of individuals in patient type i, N is the number of individuals admitted to hospital in the market and H is the set of hospitals in the market. Estimation is performed using maximum likelihood estimation and a 10 percent random sample is used to estimate demand because of large size of the data. Previous studies have shown that distance traveled to hospital has a significant effect on utility. A number of interaction terms are also included. Distance is interacted with patient diagnosis. The other interactions are between patient characteristics (the fifteen diagnosis categories listed in Table 2 and insurance type- Medicare, Medicaid, private and uninsured) and hospital characteristics (eleven variables indicating service availabilities, listed in Table 3). Interactions that should have no effect (for example a nervous system diagnosis interacted with provision of obstetrics services) are restricted to be zero.

The next step is to use the estimated parameters α, β to predict expected demand for hospitals had they provided the services or had they not provided the services.

Hospital's utility is assumed to be a weighted average of the quality of the hospital and its profits (weight of profits is normalized to 1). Hospital quality is assumed to be a linear function of service availability dummies. Hospital h's utility from providing the services T_h (T_h is a vector of dummies indicating service availability: $T_h(l) = 1$ if service *l* is provided in hospital *h*) is

$$V_h(x_h, T_h, T_{-h}, \nu, \pi, \theta) = \theta_j Q_h(T_h) + \sum_i D_{hi}(x_h, T_h, T_{-h}, \nu_i)\pi_i$$

where T_{-h} is the services provided by other hospitals in the market, $Q_h(T_h)$ is quality of hospital *h* measured by the availability of services in this work, *j* is hospital type defined as ownership type, teaching status and size, $D_{hi}(x_h, T_h, T_{-h}, \nu_i)$ is demand of patient type *i* for hospital h and π_i is average profitability of patient type i.

To estimate a hospital utility maximization model that accounts for the possibility of endogenous regressors, moment inequality methodology developed in Pakes et al. (2015) is adapted.

I allow for two sources of randomness. The first is measurement error of total profits of the hospital on part of the econometrician denoted as ξ_h. We can therefore write the hospital profits observed by the econometrician as:

$$P_h^0(x_h, T_h, T_{-h}, \nu, \pi) = P_h(x_h, T_h, T_{-h}, \nu, \pi) + \xi_h = \sum_i D_{hi}(x_h, T_h, T_{-h}, \nu_i)\pi_i + \xi_h$$

and we can rewrite the hospital's utility function as:

$$V_h\left(x_h, T_h, T_{-h}, \nu, \pi, \theta_j\right) = \theta_j T_h + P_h(x_h, T_h, T_{-h}, \nu, \pi)$$

Second, the hospital may predict its profits from providing a service with error, which is denoted as ψ_h. The hospitals prediction of its profits from choosing services T_h can therefore be written as

$$E_\psi\left(P_h\left(x_h, T_h, \tilde{T}_{-h}, \psi, \nu, \pi\right)|I_h\right) = P_h(x_h, T_h, T_{-h}, \psi, \nu, \pi) - \psi_h$$

where I_h is hospital h's information set, $\tilde{T}_{-h}$ are random variables before their realizations are known by the hospital and $E(\psi_h|I_h) = 0$ by construction.

The standard models that might be used to estimate the hospital utility function (such as logit model) would require iid errors and we would estimate using maximum likelihood. However the independence assumption may be difficult to accept because econometrician measurement error may lead to a correlation between the errors and other right hand side variables of the hospital utility function. The methodology developed in Pakes et al. (2015) avoids these problems by using a method of moments approach with inequality constraints. The primary identifying assumption used in estimation follows from hospital's objective function. Hospitals choose service availability to maximize their utility. So if hospital h of type j chooses T_h then for all other service availability choices T_h' their expected utility should be less:

$$E[V_h(x_h, T_h, T_{-h}, \nu, \pi, \theta)] \geq E[V_h(x_h, T_h', T_{-h}, \nu, \pi, \theta)]$$

That is, I assume that:

$$E_\psi\big(V_h\big(x_h, T_h, \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\big)|I_h\big) \geq E_\psi\big(V_h\big(x_h, T_h', \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\big)|I_h\big)$$

for every hospital h in the market.

The observed difference between the hospital's utility generated by observed service provision and from alternative service provision is defined to be:

$$\Delta V_h^0\big(x_h, T_h, \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\big) = V_h^0\big(x_h, T_h, \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\big) - V_h^0\big(x_h, T_h', \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\big)$$

We will require a set of instruments z_h such that $z_h \in I_h$ and $E(\xi_h|z) = 0$. Then

$$E\big(E_\psi\big(V_h\big(x_h, T_h, \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\big)|I_h\big)|z\big) \geq E\big(E_\psi\big(V_h\big(x_h, T_h', \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\big)|I_h\big)|z\big)$$

where the outer expectation is taken by the econometrician. Thus

$$E\left(\Delta V_h^0\left(x_h, T_h, \tilde{T}_{-h}, \psi, \nu, \pi, \theta_j\right)|z\right) \geq 0$$

All of the unobservables have dropped out of this inequality. Translating expectations into sample means, the equation for estimation is:

$$\frac{1}{\sum_m n_{jm}} \sum_m \sum_{h=1}^{n_{jm}} \left[\Delta V_h^0\left(x_h, T_h, \tilde{T}_{-h}, \nu, \pi, \theta_j\right) \otimes g(z)\right] \geq 0$$

where n_{jm} is the number of type *j* hospitals in market *m*, ⊗ is the Kronecker product operator and *g*(*z*) is any positive valued function of *z*. All θ_j that satisfy this system of inequalities are included in the set of feasible parameters. If no such θ_j exists, I find the value that minimizes the sum of the absolute values of the amount by which each inequality is violated.

Pakes et al. (2015) provides a proof that the estimator is consistent and also contains the methodology used to generate confidence intervals for the identified set of parameters. The limit distribution of the data used to define inequalities is estimated, repeated draws on this distribution is taken and a new estimate is calculated for each draw. The resulting vector of simulated values is used to find a 95% confidence interval. The confidence intervals have not been adjusted to account for variance introduced by the estimated demand parameters. Since the standard errors in the demand estimation are relatively low, this is unlikely to significantly affect the results.

5 Results

Because of the large size of the dataset, 10 percent random sample was used to estimate the demand for hospitals. Table 5 shows sample of the results of the estimation of the hospital choice model using MLE and including year and market fixed effects, all of the estimates are reported in Appendix-A. The results are in line with the previous hospital choice literature and are intuitive.

Higher nurse per bed significantly increases the probability that a patient will choose a hospital and distance significantly reduces the probability that a patient will choose it. Circulatory system patients place a strong positive weight on hospitals with cardiac intensive care unit and cardiac surgery; alcohol/drug patients on hospitals with alcohol units and kidney patients on hospitals with ESWL and most patient types on hospitals with imaging services.

Table 5: Sample demand estimates. *** denotes significance levels at the 1%.

Interaction Terms	Variable	Estimate	Std Error
	Distance (miles)	-0.13246***	0.000252
	Distance squared	0.000399***	8.62E-07
	Teaching	-0.20119***	0.00342
	Nurses per bed	1.411345***	0.01026
	Nurses per bed squared	-0.36049***	0.003013
Interactions: Distance	Emergency	-0.02571***	0.00035
Interactions: Obstetrics services* Pregnancy, childbirth	Medicare	1.346327***	0.049948
	Medicaid	1.248813***	0.007838
	Private	1.076838***	0.006974
	Uninsured	1.186827***	0.021353
Interactions: Cardiac ICU* Circ. Patient	Medicare	0.206648***	0.008748
	Medicaid	0.216291***	0.024376
	Private	0.187587***	0.013624
	Uninsured	0.192539***	0.031666
Interactions: MRI	Medicare	0.062747***	0.022025
	Medicaid	-0.09056***	0.008338
	Private	0.079381***	0.00735
	Uninsured	0.001212	0.022058
Interactions: MRI* Medicare	Nervous System	0.344698***	0.02733
	Respiratory System	0.30598***	0.025309
	Circulatory System	0.11439***	0.023717
	Digestive System	0.31871***	0.025898
	Hepatobiliary System	0.331506***	0.03573
	Musculoskeletal System	0.221907***	0.026069
	Skin	0.354249***	0.036063
	Endocrine System	0.277035***	0.032393
	Kidney	0.291222***	0.029396
	Female rep. System	0.312497***	0.050655
	constant	-2.44198***	0.013674
	market fixed effects	yes	

year fixed effect	yes
Number of observations	972010
Pseudo R squared	0.2996

Using the demand model, I calculate the expected profits from providing the services for each service and each hospital in the sample. For example for a hospital that does not offer alcohol unit, first I calculate the hospital's expected profits with hospital's current choice of services, then I calculate the expected profits had the hospital provided an alcohol unit. Taking a weighted average of the difference in profits providing an alcohol unit would have made over type *j* hospitals without an alcohol unit and taking a weighted average of the difference in profits not providing an alcohol unit would have made over type *j* hospitals with an alcohol unit, I get the lower and upper bounds of the value type *j* hospitals assign to providing an alcohol unit. When I consider just the 11 services I get a very large set of values that satisfies the inequality constraints for the estimates. To get a smaller set of estimates I used two step deviations at a time in addition to one step deviations. Since hospitals' choice of services should be maximizing their expected utility on the average, if a hospital does not provide both alcohol unit and obstetrics services, providing these services should lead to lower expected utility for the hospital. When two services are considered at a time, there is no θ that satisfies all the inequality constraints when estimating the values hospitals assign to providing services relative to total profits. The amount by which each inequality constraint is violated is weighted by the number of hospitals with that constraint and estimates are obtained by obtaining the value that minimizes the weighted sum of the absolute value of the amount by which each inequality constraint is violated.

Values hospitals assign to providing services relative to profits per patient and relative to total profits are estimated separately. When a hospital is observed in two years, one of the hospital-years is randomly dropped. 242 moment restrictions are used to calculate the estimates (22 moments for single deviations of service availability and 220 moments for taking deviations including two services into account at a time). Because of the large number of restrictions, estimates are singleton: there is no parameter vector that satisfies all the inequality constraints for singletons. As discussed in Pakes et al.(2015), this does not imply that we should reject the model. This result can easily be caused by the random disturbances in inequalities.

Table 6 reports values hospitals assign to providing services relative to profits per patient. Not-for-profit hospitals value providing both profitable and unprofitable services the most and for-profit hospitals value providing unprofitable services the least relative to profits per patient. Not-for-profit hospitals value providing a service $980 more than for-profit hospitals and value providing an unprofitable service $2,430 more than their for-profit counterparts relative to profits per patient. Government hospitals value providing an unprofitable service on average $2,170 more than for-profit hospitals relative to profits per patient. When we consider only big hospitals, on average not-for-profit hospitals value providing services relative to profits per patient the most and government hospitals value providing services relative to profits per patient the least. On average not-for-profits value profitable services significantly more than for-profits and for-profits value unprofitable services more than not-for-profits though the estimates do not significantly differ.

The results of hospital service valuation relative to total profits for all hospitals and only big hospitals by ownership type are reported in Table 7.When all hospitals are considered, not-for-profits value providing services relative to total profits the most. On the average, not-for-profits value services $3.7 million more than for-profits relative to total profits. On the average, not-for-profits value profitable services around $4.9 million more than for-profit hospitals and for-profit hospitals value unprofitable services $1.8 million more than not-for-profits relative to total profits. When we consider only big hospitals, not-for-profits value both unprofitable and profitable services the most relative to total profits and unexpectedly government hospitals value providing both profitable and unprofitable services the least. On average all hospitals value profitable services significantly more than unprofitable services.

Values assigned to each service separately by hospitals of different ownership types relative to profits per patient and total profits are reported in tables 9 and 10 respectively in Appendix-B. Not-for-profit hospitals value providing obstetrics services, cardiac and neonatal intensive care units, cardiac surgery, MRI and PET scan significantly more than for-profit and government hospitals.

When only big hospitals are considered, estimates of the values hospitals assign to providing services relative to profits per patient are much higher than the values estimated using all hospitals since fixed costs of providing the services are not included in the model. However, given the higher number of patients treated in big hospitals, fixed cost is a much smaller share of the total cost, hence estimated values hospitals assign to providing services are much higher and closer to the real values in magnitude. However using all hospitals in just comparison will make more sense since a lower fraction of for-profit hospitals are big hospitals and big hospitals are not necessarily representative of all hospitals. For example, a for-profit hospital is more likely to provide obstetrics services than a government hospital whereas a big for-profit hospital is less likely to provide these services than a big government hospital. Also confidence intervals are wider when only big hospitals are considered given smaller number of observations used in the analysis.

Table 6: Value assigned to services relative to profits per patient. Estimates are in $1000. 95% confidence intervals of the estimates are reported in parenthesis.

	Not-for-profit	For-profit	Government
		All Hospitals	
All Services	-1.32	-2.30	-1.80
	(-1.39, -1.26)	(-2.41, -2.27)	(-1.91, -1.75)
Unprofitable Services	-1.71	-4.14	-1.97
	(-2.43, -0.77)	(-4.95, -2.85)	(-2.63, -1.85)
Profitable Services	1.20	0.30	-0.95
	(1.01, 1.31)	(0.10, 0.45)	(-1.11, -0.59)
Hospital-years	918	165	246
		Big Hospitals	
All Services	1.25	0.69	-0.32
	(1.03, 1.51)	(0.60, 0.81)	(-0.38, -0.14)
Unprofitable Services	0.17	0.52	-1.08
	(-0.03, 0.33)	(0.30, 0.62)	(-1.21, -1.02)
Profitable Services	3.19	0.80	0.34
	(2.56, 3.46)	(0.63, 0.93)	(0.20, 0.58)
Hospital-years	426	48	56

Table 7: Value assigned to services relative to total profits. Estimates are in $1000. 95% confidence intervals of the estimates are reported in parenthesis.

	Not-for-profit	For-profit	Government
		All Hospitals	
All Services	-192	-3880	-8315
	(-238, -78)	(-4311, -3812)	(-8442, -7804)
Unprofitable Services	-7854	-6028	-7304
	(-7898, -7763)	(-6042, -5913)	(-7559, -7050)
Profitable Services	2424	-2488	-9326
	(2382, 2473)	(-2514, -2344)	(-9576, -9200)
Hospital-years	918	165	246
		Big Hospitals	
All Services	6828	-2926	-4157
	(6668, 6941)	(-3375, -2285)	(-4418, -3395)
Unprofitable Services	-2271	-4696	-7872
	(-2286, -2256)	(-4824, -4545)	(-8444, -7265)
Profitable Services	12489	-1156	-2741
	(12478, 12495)	(-1227, -1085)	(-3003, -1884)
Hospital-years	426	48	56

6 Discussions and Conclusion

This paper investigates the differences between hospitals by ownership type in terms of value assigned to service provision relative to profits in a structural way. The main contributions of this paper are analyzing the differences between hospitals by ownership type employing a demand model and getting estimates of values relative to profits assigned to service provision allowing for both measurement error by econometrician and expectational error by hospital.

Despite the absence of requirements, not-for-profit hospitals value providing services relative to both profits per patient and total profits significantly more than for-profit and government hospitals. Not-for-profits value unprofitable services significantly more than for-profit hospitals relative to profits per patient. Also not-for-profits value both unprofitable and profitable services relative to total profits significantly more than for-profit and government hospitals when we consider only big hospitals. Only government hospitals value providing unprofitable services more than profitable services relative to total profits on average.

The results imply that Pauly-Redisch (1973) profit-maximization model does not accurately describe the hospital market because hospitals value service provision relative to profits quite differently by ownership type. Not-for-profit hospitals are found to significantly differ from their for-profit counterparts in terms of value they assign to service provision relative to profits when Newhouse's (1970) output maximization theory is tested in a structural way. On average not-for-profits value services more than their for-profit counterparts relative to profits per patient and total profits. Not-for-profits value unprofitable services more than for-profit hospitals, so they are more likely to provide the services for-profits are less willing to provide, which will be needed by the market, supporting Weisbrod's (1988) market output maximization theory. Analyzing the differences in behavior of not-for-profits by market ownership mix might be helpful to further distinguish between own output maximization, market output maximization and mixture theories.

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Appendix-A

Table 8: Demand estimates. ***, **, and * denote significance levels at the 1%, 5% and 10% respectively.

Interaction Terms	Variable	Estimate	Std Error
	Distance (miles)	-0.13246***	0.000252
	Distance squared	0.000399***	8.62E-07
	Teaching	-0.20119***	0.00342
	Nurses per bed	1.411345***	0.01026
	Nurses per bed squared	-0.36049***	0.003013
Interactions: Distance	Emergency	-0.02571***	0.00035
Interactions: Obstetrics services* Pregnancy, childbirth	Medicare	1.346327***	0.049948
	Medicaid	1.248813***	0.007838
	Private	1.076838***	0.006974
	Uninsured	1.186827***	0.021353
Interactions: Cardiac ICU* Circ. Patient	Medicare	0.206648***	0.008748
	Medicaid	0.216291***	0.024376
	Private	0.187587***	0.013624
	Uninsured	0.192539***	0.031666
Interactions: Neonatal ICU* Newborn baby	Medicare	1.748876***	0.09796
	Medicaid	1.433927***	0.009205
	Private	1.330564***	0.008268
	Uninsured	1.330881***	0.02482
Interactions: Burn unit* burn patient	Medicare	3.517683***	0.213253
	Medicaid	3.983998***	0.100829
	Private	3.783515***	0.133305
	Uninsured	4.487784***	0.238587
Interactions: Alcohol unit* alcohol patient	Medicare	1.76453***	0.040013
	Medicaid	1.609947***	0.018304
	Private	1.855699***	0.028116
	Uninsured	1.797789***	0.03188
Interactions: ESWL* Kidney patient	Medicare	0.187581***	0.015462
	Medicaid	0.274308***	0.034128
	Private	0.263132***	0.023808
	Uninsured	0.123513**	0.054755
Interactions: Psych. Emergency* mental patient	Medicare	1.4249***	0.020952
	Medicaid	1.354135***	0.013286
	Private	1.364785***	0.014664
	Uninsured	1.31697***	0.025868
Interactions: Cardiac surgery* circ. Patient	Medicare	0.71892***	0.00801
	Medicaid	0.699698***	0.022017
	Private	0.916749***	0.012353
	Uninsured	0.54791***	0.028883

Interactions: MRI	Medicare	0.062747***	0.022025
	Medicaid	-0.09056***	0.008338
	Private	0.079381***	0.00735
	Uninsured	0.001212	0.022058
Interactions: PET scan	Medicare	0.172605***	0.020754
	Medicaid	0.412232***	0.007435
	Private	0.459303***	0.00668
	Uninsured	0.168743***	0.01851
Interactions: Diag. Radioisotope facility	Medicare	-0.31862***	0.021653
	Medicaid	-0.24109***	0.008295
	Private	-0.19159***	0.007268
	Uninsured	-0.13669***	0.020992
Interactions: MRI* Medicare	Nervous System	0.344698***	0.02733
	Respiratory System	0.30598***	0.025309
	Circulatory System	0.11439***	0.023717
	Digestive System	0.31871***	0.025898
	Hepatobiliary System	0.331506***	0.03573
	Musculoskeletal System	0.221907***	0.026069
	Skin	0.354249***	0.036063
	Endocrine System	0.277035***	0.032393
	Kidney	0.291222***	0.029396
	Female rep. System	0.312497***	0.050655
Interactions: MRI* Medicaid	Nervous System	0.653275***	0.034503
	Respiratory System	0.607747***	0.025336
	Circulatory System	0.344912***	0.027545
	Digestive System	0.647498***	0.029603
	Hepatobiliary System	0.544566***	0.045515
	Musculoskeletal System	0.629833***	0.040556
	Skin	0.586726***	0.04861
	Endocrine System	0.576893***	0.040117
	Kidney	0.543072***	0.044539
	Female rep. System	0.538102***	0.060466
Interactions: MRI* private	Nervous System	0.355254***	0.022981
	Respiratory System	0.385682***	0.021057
	Circulatory System	0.047978***	0.015691
	Digestive System	0.338569***	0.017608
	Hepatobiliary System	0.311936***	0.03011
	Musculoskeletal System	0.25101***	0.019119
	Skin	0.371843***	0.034218
	Endocrine System	0.302374***	0.028178
	Kidney	0.370139***	0.030555
	Female rep. System	0.298005***	0.024129
Interactions: MRI* uninsured	Nervous System	0.319986***	0.057779
	Respiratory System	0.35803***	0.051491

	Circulatory System	0.214387***	0.042243
	Digestive System	0.317885***	0.04736
	Hepatobiliary System	0.249304***	0.064095
	Musculoskeletal System	0.308135***	0.059806
	Skin	0.37142***	0.064118
	Endocrine System	0.320793***	0.070331
	Kidney	0.386907***	0.075914
	Female rep. System	0.295242***	0.088275
Interactions: PET scan* Medicare	Nervous System	0.312108***	0.024793
	Respiratory System	0.176432***	0.02318
	Circulatory System	0.193388***	0.02201
	Digestive System	0.259772***	0.023727
	Hepatobiliary System	0.319494***	0.031327
	Musculoskeletal System	0.398068***	0.023937
	Skin	0.209812***	0.031577
	Endocrine System	0.223652***	0.02847
	Kidney	0.276912***	0.026345
	Female rep. System	0.429472***	0.045391
	Neoplasm	0.193217***	0.016066
Interactions: PET scan* Medicaid	Nervous System	0.318203***	0.029333
	Respiratory System	0.089597***	0.021484
	Circulatory System	-0.10597***	0.021835
	Digestive System	0.104502***	0.02467
	Hepatobiliary System	0.081272**	0.037425
	Musculoskeletal System	0.412798***	0.034483
	Skin	0.08095**	0.039382
	Endocrine System	0.158827***	0.03416
	Kidney	0.107539***	0.037151
	Female rep. System	0.063917	0.049273
	Neoplasm	0.299415***	0.037363
Interactions: PET scan* private	Nervous System	0.362194***	0.01989
	Respiratory System	0.083197***	0.017437
	Circulatory System	0.022635*	0.013096
	Digestive System	0.150554***	0.014702
	Hepatobiliary System	0.069679***	0.024847
	Musculoskeletal System	0.371566***	0.01659
	Skin	0.101576***	0.02837
	Endocrine System	0.221032***	0.024203
	Kidney	0.051061**	0.025693
	Female rep. System	0.093726***	0.02091
	Neoplasm	0.19467***	0.019385
Interactions: PET scan* uninsured	Nervous System	0.446338***	0.044867
	Respiratory System	0.256535***	0.040311
	Circulatory System	0.123062***	0.032506

	Digestive System	0.217807***	0.036667
	Hepatobiliary System	0.219***	0.050271
	Musculoskeletal System	0.484999***	0.048124
	Skin	0.355498***	0.048583
	Endocrine System	0.271059***	0.054402
	Kidney	0.262435***	0.058883
	Female rep. System	0.349793***	0.070222
	Neoplasm	0.264213***	0.062476
Interactions: Diagnostic Radioisotope Facility* Medicare	Nervous System	0.793112***	0.026427
	Respiratory System	0.856795***	0.02456
	Circulatory System	0.526136***	0.023316
	Digestive System	0.817722***	0.025089
	Hepatobiliary System	0.799673***	0.034014
	Musculoskeletal System	0.863254***	0.025208
	Skin	0.735892***	0.034727
	Endocrine System	0.842671***	0.031
	Kidney	0.733273***	0.028476
	Female rep. System	0.715167***	0.047803
Interactions: Diagnostic Radioisotope Facility* Medicaid	Nervous System	0.413796***	0.033453
	Respiratory System	0.502852***	0.024515
	Circulatory System	0.231226***	0.026834
	Digestive System	0.480329***	0.028572
	Hepatobiliary System	0.577888***	0.043626
	Musculoskeletal System	0.404833***	0.039307
	Skin	0.456933***	0.047189
	Endocrine System	0.5276***	0.038301
	Kidney	0.426995***	0.042876
	Female rep. System	0.547579***	0.057989
Interactions: Diagnostic Radioisotope Facility* private	Nervous System	0.555291***	0.021631
	Respiratory System	0.589944***	0.019949
	Circulatory System	0.333196***	0.015649
	Digestive System	0.608553***	0.016676
	Hepatobiliary System	0.695002***	0.028181
	Musculoskeletal System	0.597944***	0.018139
	Skin	0.540144***	0.03235
	Endocrine System	0.615531***	0.026506
	Kidney	0.491802***	0.029456
	Female rep. System	0.605788***	0.022693
Interactions: Diagnostic Radioisotope Facility* uninsured	Nervous System	0.589738***	0.055934
	Respiratory System	0.577983***	0.049304
	Circulatory System	0.356146***	0.040414
	Digestive System	0.676137***	0.045336
	Hepatobiliary System	0.718649***	0.061506
	Musculoskeletal System	0.592214***	0.057644

	Skin	0.488531***	0.062075
	Endocrine System	0.580226***	0.067839
	Kidney	0.499195***	0.072495
	Female rep. System	0.609432***	0.085174
	constant	-2.44198***	0.013674
	market fixed effects	yes	
	year fixed effect	yes	
Number of observations		972010	
Pseudo R squared		0.2996	

Appendix-B

Table 9: Value assigned to services relative to profits per patient. Estimates are in $1000. 95% confidence intervals of the estimates are reported in parenthesis

	All Hospitals			Big hospitals		
	Not-for-profit	For-profit	Government	Not-for-profit	For-profit	Government
Alcohol unit	-1.71	-4.80	-1.30	1.91	-2.04	-1.88
	(-1.77, -1.64)	(-4.89, -4.73)	(-1.37, -1.28)	(0.54, 2.50)	(-2.56, -1.68)	(-2.19, -1.70)
Burn unit	-1.66	-1.55	-2.48	-0.58	0.66	-4.91
	(-1.67, -1.64)	(-1.57, -1.53)	(-2.53, -2.47)	(-1.64, -0.47)	(0.04, 1.00)	(-5.22, -4.67)
Cardiac ICU	-0.97	-0.75	-0.35	-0.55	-1.46	0.41
	(-1.04, -0.90)	(-0.96, -0.62)	(-0.38, -0.30)	(-0.99, 0.57)	(-1.80, -1.10)	(0.18, 0.67)
Cardiac Surgery	-2.67	0.68	-0.94	0.29	-0.22	-0.30
	(-2.94, -2.40)	(0.36, 0.97)	(-1.25, -0.59)	(-0.40, 1.41)	(-0.64, 0.39)	(-0.72, 0.12)
Diag. Rad. Facility	-1.64	-3.37	-2.05	-0.16	-1.50	0.43
	(-1.80, -1.50)	(-3.58, -3.21)	(-2.47, -1.68)	(-0.92, 1.71)	(-1.89, -0.49)	(0.05, 0.86)
ESWL	-2.52	-5.25	-0.55	3.12	-0.10	-0.51
	(-2.54, -2.50)	(-5.43, -5.08)	(-0.60, -0.54)	(1.89, 3.93)	(-0.71, 0.38)	(-0.88, -0.14)
MRI	0.64	0.99	-1.62	3.19	2.85	-0.13
	(0.55, 0.69)	(0.89, 1.01)	(-1.69, -1.53)	(2.96, 4.11)	(2.50, 3.44)	(-0.57, 0.44)
Neonatal ICU	-3.54	-0.54	-0.98	-0.80	0.63	0.24
	(-3.57, -3.50)	(-0.66, -0.51)	(-1.05, -0.90)	(-1.29, 0.36)	(0.28, 0.78)	(0.06, 0.55)
Obstetrics	-1.14	-0.65	-1.02	0.59	-0.78	0.94
	(-1.26, -1.02)	(-0.69, -0.44)	(-1.06, -0.98)	(0.39, 1.01)	(-1.01, -0.59)	(0.79, 1.13)
PET Scan	0.10	1.96	-0.11	2.52	2.83	0.82
	(-0.09, 0.29)	(1.73, 2.20)	(-0.39, 0.15)	(1.08, 4.29)	(2.02, 3.39)	(0.34, 1.42)
Psych. Emerg.	2.16	2.13	-2.31	0.23	0.49	0.21
	(2.10, 2.21)	(2.03, 2.15)	(-2.40, -2.26)	(-1.06, 2.05)	(0.01, 0.98)	(-0.06, 0.58)
Hospital-years	918	165	246	426	48	56

Table 10: Value assigned to services relative to total profits. Estimates are in $1000. 95% confidence intervals of the estimates are reported in parenthesis

	All Hospitals			Big Hospitals		
	Not-for-profit	For-profit	Government	Not-for-profit	For-profit	Government
Alcohol unit	-18029	-7947	-20328	-15469	-8819	-29387
	(-18337, -12889)	(-10477, -7157)	(-20989, -20192)	(-15755, -15172)	(-11622, -7376)	(-31487, -29026)
Burn unit	-14848	-6355	-5166	-9552	-4307	-5467
	(-16436, -12144)	(-8433, -4435)	(-7494, -5039)	(-10507, -8788)	(-8097, -2736)	(-5903, -4610)
Cardiac ICU	-1691	-2275	-3112	-161	-1864	-777
	(-2188, -1044)	(-2535, -2015)	(-4366, -1905)	(-566, 669)	(-3462, -201)	(-1316, -324)
Cardiac Surgery	130	-4423	-3977	-318	-1121	-9661
	(124, 134)	(-4472, -4356)	(-4185, -3924)	(-1082, 671)	(-3721, 1745)	(-9963, -8664)
Diag. Rad. Facility	-5386	-2793	-674	411	76	339
	(-5603, -5192)	(-3099, -2321)	(-1089, -401)	(346, 484)	(51, 141)	(334, 360)
ESWL	-1903	-3068	-687	-653	-2070	-1298
	(-2203, -1639)	(-3298, -2458)	(-1590, -108)	(-1264, -207)	(-3169, -362)	(-2344, -501)
MRI	10485	-1414	-4062	14366	-1141	-3108
	(9445, 11623)	(-1584, -1256)	(-4134, -3975)	(13582, 15408)	(-3259, 1285)	(-3584, -877)
Neonatal ICU	14645	227	727	21910	1574	3765
	(14371, 15108)	(-16, 349)	(113, 1341)	(20955, 22674)	(-612, 3314)	(3256, 4618)
Obstetrics	20291	2063	1968	30763	2738	7790
	(19730, 21201)	(1995, 2334)	(691, 4358)	(30416, 31047)	(1236, 3576)	(6938, 8301)
PET Scan	31505	-4810	-29761	34025	-3122	-29247
	(30325, 31919)	(-5285, -4497)	(-29818, -29724)	(33285, 35105)	(-6882, -870)	(-29965, -28320)
Psych. Emerg.	-6353	-5483	-3299	-3964	-4680	-2521
	(-6593, -5700)	(-6736, -4857)	(-3839, -1849)	(-5164, -2006)	(-6193, -2902)	(-3014, -2201)
Hospital-years	918	165	246	426	48	56

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