International Journal of Industrial Organization
20 (2002) 461–492

International Journal of Industrial Organization

www.elsevier.com/locate/econbase

What do not-for-profit hospitals maximize?

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Abstract

Massive structural change is occurring in health care provision in the United States, significantly reducing the number of not-for-profit suppliers. This trend is fueled in part by government policies. To evaluate these policies one must know about the motives of not-for-profit health care providers. The theory of not-for-profit hospitals suggests buyers may prefer dealing with sellers who are not acting out of avarice. Yet, this theory does not imply the absence of rent seeking motives. We formulate a test of not-for-profit hospitals' goals and apply it to hospitals in Virginia. Modeling average revenues as a function of caseload (private, Medicare, Medicaid, charity), we identify prices as latent variables. By analyzing the response of the estimated private price to exogenous differences in Medicare, Medicaid and charity caseload, we reject the hypothesis that not-for-profit hospitals maximize profits (i.e. maximize rents for a set of agents who 'control' the hospital). We also reject pure welfare (output) maximization. These results, combined with other evidence we discuss, are consistent with the hypothesis that these hospitals consider both profits and output as objectives. Current US government policies treat all not-for-profit hospitals as if they were profit maximizers. These policies appear to be biased towards reenforcing the trend towards less health care provision from not-for-profits, and our results suggest that this may not be entirely beneficial to consumers.

JEL classification: L31; L21; I11

Keywords: Health care; Not-for-profit hospitals; Profit maximizers

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0167-7187/02/$ – see front matter
PII: S0167-7187(00)00104-1

1. Introduction

The theory of not-for-profit [NFP] firms in many sectors (e.g. health) suggests that, in the presence of asymmetric information, buyers might prefer to transact with sellers whom they believe are not acting solely out of avarice (Rose-Ackerman, 1986; Institute of Medicine, 1986; Yoder, 1986; Arrow, 1963). Yet, even if the law prohibits NFP institutions from overtly distributing profits to residual claimants, it is not axiomatic that they act solely to maximize social surplus. Rent extraction and disbursement can occur in many different ways. When formulating policies, it is essential to know how hospitals will react to a new environment.

We propose and implement an empirical test of NFP hospital behavior in which output maximization, subject to a zero-profit constraint, approximates second-best social surplus maximization. We consider an objective function in which both profits and output are valued by the NFP hospital. This permits testing the following two polar null hypotheses: *profit maximization* versus *output maximization*. **For our sample**, it appears that NFP hospitals extract some rents, but also give weight to social surplus in their objective functions. Our results suggest that NFP hospitals may deviate significantly from profit maximization.

It should be noted that our results are for Virginia hospitals. Hospital behavior may vary across states for many reasons, including state regulation and the extent to which the state is urban. Given the uniqueness of Virginia's data, we cannot extrapolate to other environments with great confidence. But, policy analysts should consider the possibility of the type of behavior we find herein. For example, the consequences of mergers between NFP hospitals may differ significantly from those between for-profit [FP] hospitals or acquisitions of NFPs by FPs.[1] Yet the United States antitrust authorities and courts treat these as essentially identical transactions (cf. Lynk, 1995). Further, some have called for containing health care costs by lowering prices paid by government insurance plans and some private 'managed care' plans.[2] This may yield 'cost shifting' at NFPs, rather than lowering the average cost of care.

The appropriate evaluation of policies such as the above requires greater knowledge of the objectives of NFP hospitals, which can come only if we obtain access to better data than are currently public (The data herein, which are far from ideal, were made available through antitrust litigation).

[1] See, e.g. *USA Today*, June 27, 1996 p. 1D, 'Mergers hurt health care, group says.' Of about 5500 hospitals in 1995, 447 were involved in mergers, 58 of which were NFPs acquired by FPs. This article presents views on both sides of the issue of whether these conversions to FP status will be in the best interests of (prospective) patients.

[2] *The New York Times*, April 14, 1996, p. 1, 'Hospitals Look on Charity Care As Unaffordable Option of Past,' discusses the insurance (private and government) squeeze on hospitals.

This paper is organized as follows. Section 2 presents some institutional background; Section 3 provides literature on NFP hospitals; Section 4 presents the theory and testable hypotheses. Section 5 discusses the data; Section 6 the empirical methodology; and Section 7, the results. Sections 8 and 9 sketch some policy implications and then conclude.

2. Institutional background

In the United States in the 1980s, four categories dominated medical hospitalization 'coverage.' First, employers provided private employee insurance programs.[3] These programs typically were indemnity insurance policies which paid a percentage of a patient's medical bills.[4] Second, Medicaid, a joint Federal/State medical insurance coverage program, covered those poor who qualified for welfare benefits of various kinds. Individuals employed at low wages by employers without medical insurance programs often were not eligible for Medicaid. Third, the elderly (and smaller numbers of the blind and disabled) were eligible for Federal Medicare insurance. Eligibility depended on age (or disability) and qualification for Social Security, also called Aid to the Aged, Blind and Disabled. Medicare covered some, but not all, medical needs of the beneficiaries. Finally, a portion of the population was not covered by any medical insurance. To the extent that this population is mostly poor, their 'insurance' is in some sense the provision of 'charity' medical services by physicians and hospitals. In the State of Virginia, for our sample, the breakdown of total patient days was: privately paid hospitalization, 37 percent; Medicare, 47 percent; and Medicaid, 9 percent. The remaining 7% of patient days was attributed to charity care (carried as either charity or bad debt on hospital books).

Hospitals are required by Federal law to accept all patients for emergency care. A hospital may violate State or Federal laws if it denies acute care on the basis of ability to pay. It may further risk its reputation and even its NFP tax status if it does so. As we note later, 'patient dumping' (denying admission to indigent patients) is minimal, though a few egregious instances have been in the public spotlight.

As noted by Arrow (1963) and others, prospective patients may prefer medical

[3] In more recent years there has been a significant move toward managed care insurance. These, Preferred Provider Organizations (PPOs) and Health Maintenance Organizations (HMOs), are insurance programs which (if not vertically integrated) bargain for lower rates from specific providers (a subset of doctors and hospitals) or even dictate what medical procedures a prospective patient is allowed to have under medical coverage. In Virginia at the time of this study, most private patient billings were to indemnity insured patients.

[4] For example, a policy might cover 80% of all hospital charges, sometimes with a 'major medical' agreement to pay 100% above some maximum patient liability per year.

service from NFP or government hospitals for endogenous reasons. Given the significant asymmetry of information between the care provider and the patient, patients may fear correctly that the profit motive may lead to inappropriate levels of care. As such, NFP hospitals are granted special tax status in the United States. Such hospitals can make a profit (revenues may exceed costs) and not face the income taxes that would be levied on a FP corporation. But, the investors who created the NFP hospital cannot act as residual claimants for such net revenues. Profits cannot be disbursed to the ‘investors.’ Investors may be repaid their capital investment plus interest, but this payment level is constrained to be at reasonable prevailing interest rates and not conditional upon hospital net revenues.[5]

NFP hospitals include church- and government-owned hospitals. Most NFPs, however, are ‘community’ hospitals.[6] These are secular hospitals often established with community support. Especially in an area like Virginia in which there are many smaller towns and villages, the Boards of Directors of NFP hospitals are comprised in no small part of prominent citizens, many of whom may be in the business community. Since the business community will be purchasing employee insurance at rates which reflect local hospitalization charges, Boards have an incentive to maintain ‘reasonable’ prices. Furthermore, Board members typically would want to avoid a personal association with a hospital perceived to have excessive prices or low or declining quality of care.

There are also FP hospitals in the United States. Many states historically have prohibited the operation of FP hospitals, although those prohibitions are fewer today. A single FP acute care hospital in Virginia was dropped from our sample. A variety of studies contrasting FP and NFP hospitals are reviewed in Lynk (1995). Some studies suggest FP hospitals have higher prices while others do not. The differences in study results may reflect methodologies, time periods and other factors; the issue is not settled.

Some states regulate pricing and some require that [list] prices on certain procedures be made public. Many, like Virginia, have been less interventionist in the pricing decisions of hospitals. While prices are not directly regulated, hospitals do report revenues to the state (We use these revenue reports as a portion of our data). With the recent expansion of HMOs and PPOs, individual insurance plans now play a much larger role in negotiating prices than was the case in the mid 1980s when indemnity insured patients paid little of the actual cost of care and

[5] A multi branch NFP, such as one owned by a church, may be in a position to allocate rents between units, making a ‘profit’ in one unit to subsidize another.

[6] Lynk (1995) provides the distribution of hospital patient days by type for the United States as a whole. Community, church and government hospitals account for 62, 20 and 18% of NFP hospital patient days, respectively. FP hospitals account for 9% of all hospital patient days. Only one FP hospital operated in Virginia, accounting for 1% of the patient days in our data.

shopped mainly for amenities, specific services or convenience (cf. Dranove et al., 1993).

One final institutional point on the state of hospital capacity relative to demand is relevant for estimation. Due to technical change, revised medical thought, and changing insurance patterns, hospitalization rates have been falling in the United States. The result is almost universal excess capacity in the supply of hospital services, leading to numerous hospital failures and mergers. In our sample the average hospital utilization rate is 62% of capacity.

3. NFP hospitals' objectives

Three recent studies bear upon NFP hospitals' objective functions. Dranove (1988) proposes a model in which hospitals maximize utility from output (number of patients) and profits and derives conditions leading to 'cost-shifting.' In the traditional hospital literature, 'cost-shifting' occurs when NFP hospitals raise prices to private paying patients in response to cutbacks in Medicare and Medicaid reimbursement rates (prices). Specifically, Dranove analyzes changes in prices of Illinois hospitals between 1981 and 1983. He treats both case mix and quality as 'fixed effects.' For that time period, the case mix reporting that we take advantage of was not yet instituted. His independent variables are hospital beds, profits from government patients, and costs per admission. He concludes that these hospitals raised prices to privately insured patients in response to large Medicaid price decreases in Illinois.

Hoerger (1991) hypothesizes that NFP hospitals behave differently than FP hospitals. He compares 'profitability' fluctuations of NFP hospitals to those of FP hospitals over time. As we note below, cross sectional profitability is not a probative measure when contrasting NFP and FP behavior, but Hoerger feels that fluctuations in profits may provide some insights. His test is based upon the NFP hospitals' zero-profit constraint. He hypothesizes that NFP's profits should be close to their constrained levels and, hence, vary less across time than FP's profits. This is confirmed in his data.

Lynk (1995) looks at nongovernment patient 'net prices' of California hospitals in 1989 as they are influenced by concentration and market share. As he points out, prices, not margins, are best suited for analyzing NFP behavior; if some rent-seeking group is capturing profits from a NFP hospital's revenues, it must do so by elevating costs (payments in kind or funds counted as a hospital expense). Managerial rent capture would be reflected in managerial amenities; physician rent capture in elevated medical staff costs. Low margins for NFPs should be viewed as reflecting their tax status, and need not imply that prices are below profit maximizing levels.

As California has numerous FP hospitals, Lynk contrasts FP and NFP net price responses to market structure. His results overall are consistent with other hospital studies: higher concentration does not lead to higher prices. Lynk's definition of 'price' is a net price based on all private net revenues for nongovernment patients. If a hospital has a private price net of discounts, P^P, and a 10% charity (nonpaying) clientele, then his price measure would be $0.9{*}P^P$. To the extent that the charity patient mix is higher for NFP hospitals, this is included in his estimated price effects. This distinction will be revisited in contrasting our results with his.

Our study provides an alternative empirical test to discriminate between various formulations of NFP hospitals' objective functions. Our theory uses Dranove's (1988) objective function based upon both profits and total output. We add extensions that were not required for his tests but are essential for ours. We require a model of more patient categories and a more general cost structure. To test the polar hypothesis that hospitals are social welfare maximizing, we need to add a zero-profit constraint.[7]

Using this theoretical structure we construct latent variables to represent the Medicaid, Medicare and private patient prices in Virginia. From the behavior of these prices in response to exogenous differences across hospitals and across time, we can make some inferences about hospital pricing behavior.

4. The model

The theory for the most part requires only a formal statement of the objective function and constraints. Once these are understood, straight forward intuition can be discussed in the text. The solution of the model is only needed for some subtle sufficiency conditions and is provided in Appendix A.

Hospitals treat patients in four different patient categories: private [P], Medicare [R], Medicaid [D], and charity [C]. Let Q^τ be the number of τ patients treated by the hospital and let P^τ be the corresponding price (or net revenue) for $\tau = $ P,R,D,C. Prices and quantities are exogenously determined for Medicare, Medicaid and charity patients. The demand curve for private patients, $P^P(Q^P)$, is assumed to be downward sloping while the net revenue from charity patients is assumed to equal zero, $P^C = 0$. In this theoretical discussion, we assume that all patients are in the same disease category and use the same resources regardless of patient category.

We shall assume that government reimbursements exceed marginal costs, so

[7] Dranove (1988) simplifies the model by assuming constant and equal marginal costs (MC) and average costs (AC). Our test uses the distinction that (short run) MC$<$AC for hospitals facing excess capacity and allows for the possibility of nonconstant MC. The distinction between MC and AC is central to Medicaid reimbursement rates. States wish to pay Medicaid reimbursements at close to MC levels (Altman, 1992). The American Hospital Association, US Prospective Payment Assessment Commission (1992), finds Medicaid reimbursement rates to be about 80% of AC and most analysts feel that this rate generally covers MC.

there is no incentive to ration Medicare or Medicaid patients.[8] Accordingly we maintain the assumption that the quantities of Medicare and Medicaid patients are exogenous (not rationed).

For patients such as charity patients for which reimbursement does not exceed short run marginal cost, endogenous rationing appears to be a possibility. As refusal of emergency care is a Federal offense and NFP status may be sacrificed by a systematic refusal to admit these patients, we shall treat its incidence as exogenous. A 1982 national survey (which included the 9% of hospitals that are FP hospitals) provides some evidence of the relative insignificance of the phenomenon. Only 4% of uninsured patients reported that they had been refused care for financial reasons (Robert Wood Johnson Foundation, 1983).

Let $C(\Sigma_\tau Q^\tau)$, for $\tau = P,R,D,C$, be the total cost of treating all patients. We assume that $C' > 0$ while $C'' \geqslant 0$.[9]

Suppose the hospital maximizes the following general utility function that includes profits and the number of patients of various types.[10] With Q^R, Q^D and Q^C exogenous, the hospital maximizes utility over the quantity of private patients, Q^P:

$$\begin{aligned} U &= U(\pi, Q^P, Q^R, Q^D, Q^C) \\ &= U\Big([P(Q^P)Q^P + P^R Q^R + P^D Q^D - C(\sum_\tau Q^\tau)], Q^P, Q^R, Q^D, Q^C\Big) \end{aligned} \tag{1}$$

(We follow the convention of maximizing over quantity and solving for the private price P^P).

Our goal is to characterize some comparative static results. Specifically, for empirical implementation we find it useful to know $\partial P^P / \partial Q^\tau$, $\tau = R,D,C$. The intuition of this comparative static for the polar cases is simple and we discuss these polar cases first.

4.1. Profit maximization: no utility weight on any quantity

This case is simple. Since private marginal revenue will be set equal to firm (short run) marginal costs, MR = MC, the effect of an increase in any exogenous

[8] It is not clear that Medicaid prices exceed marginal costs at all times and in all locations. We have heard from some sources that they probably did so for much of our sample. Since this assumption *significantly* simplifies our theoretical discussion and has no influence on the empirical tests upon which we rely, we assume that Medicaid prices exceed marginal costs.

[9] We exclude $C'' < 0$ for three reasons: it significantly simplifies the analysis; our empirical results suggest that on average (short run) $C'' > 0$; and general knowledge of the industry conditions suggests that, despite significant excess capacity, hospitals perceive MC to be rising at the current margin. Note that this is not inconsistent with substantial scale economies for some services (cf. Dranove et al., 1992).

[10] We assume that each of Medicare, Medicaid and charity demands are exogenous; only the private patient demand is endogenous. Yet, separate treatment of these three categories is necessary. Our test is based upon the different price-marginal cost margins of the different exogenous patient categories.

demand will uniformly affect MC (if cost is a function of total quantity, C' is simply a function of total quantity). For nondecreasing short run marginal costs this implies

$$0 \leqslant \partial P^P/\partial Q^R = \partial P^P/\partial Q^D = \partial P^P/\partial Q^C \tag{2}$$

with strict inequality if $C''>0$. As should be clear, in the context of this model this applies to present discounted value maximization as well.

4.2. Quantity maximization: no weight on profits and positive weight on private patients

This case is also simple. Since the firm must break even, the profit constraint will bind. Now consider adding one more exogenously determined patient. We must first characterize prices for the exogenous patient categories. These are $P^R > P^D > MC > P^C = 0$. Suppose that an additional charity patient were added to the hospital. Since $0 = P^C < MC$, to break even (meet the profit constraint) the hospital must raise the private price. Consider instead what would happen if the additional patient were a Medicare patient. If profits are zero and a single additional patient is added with price above MC, the private price must be reduced to reestablish zero profits. Note that if the increase in quantity had been a Medicaid patient, with a lower gap between price and MC, the private price reduction (imposed by the zero-profit constraint) would be smaller than in the case of an additional Medicare patient. This implies:

$$\partial P^P/\partial Q^R < \partial P^P/\partial Q^D < 0 < \partial P^P/\partial Q^C \tag{3}$$

4.3. Intermediate cases: utility weight on both profits and private patient quantity

The simplest case is when the utility weight on profits is low. Then the zero-profit constraint still will bind. This case is indistinguishable from the quantity maximization case.

The more interesting cases are those for which the maximization implies a private price above average costs, but below the price that would equate marginal costs and marginal revenues. One perfectly reasonable assumption would be to maintain that the results should be ‘between’ the two polar results of profit maximization and of quantity maximization. This would suggest

$$\begin{aligned} \partial P^P/\partial Q^R \quad & \leqslant \partial P^P/\partial Q^D \leqslant \partial P^P/\partial Q^C, \text{ with} \\ & \partial P^P/\partial Q^R \gtreqless 0,\ \partial P^P/\partial Q^D \gtreqless 0, \text{ and} \\ & \partial P^P/\partial Q^C > 0 \end{aligned} \tag{4}$$

Since our tests depend upon how (4) differs from (2) and (3), we elaborate. In (2) all of the derivatives are equal, and they are only weakly positive. In (3), however, all the derivatives are unequal, two are strongly negative and one is strongly positive. So in the first line of (4) we note that the derivatives, if unequal, are ordered as in (3). In line 2, we recognize that the two derivatives which have opposite signs in (2) and (3) now have indeterminate signs. Finally in line 3, the charity effect, which is weakly positive in (2) and strongly positive in (3), must be strongly positive in (4) as well.

In addition, note that if $C''=0$, $\partial P^P/\partial Q^R$ is zero with profit maximization and negative with quantity maximization. But if $C''>0$, $\partial P^P/\partial Q^R$ is positive for profit maximization and negative for quantity maximization. An intermediate result, proved in Appendix A for a 'well behaved' utility function, is that $C''>0$ is necessary for $\partial P^P/\partial Q^R$ to be positive. The rest of the characterization above also is demonstrated in that Appendix.

4.4. Testable implications

An understanding of the testable implications requires a brief description of the testing model. The model uses hospital revenue and other data to estimate prices as latent variables, such that we arrive at price estimates of the form $\hat{P}^R=\hat{\alpha}X$, $\hat{P}^D=\hat{\beta}Y$, and $\hat{P}^P=\hat{\gamma}Z$, where X, Y, and Z are vectors of exogenous variables. For P^P the vector of explanatory variables, Z, includes the exogenous quantities Q^R, Q^D and Q^C. Once these functions are estimated we can find each of the derivatives in (2), (3) and (4) above.

The theory suggests a series of derivative tests, but we focus on only two here. We state two sufficiency conditions: one for rejecting profit maximization and one for rejecting quantity maximization. Our focus is dictated by our results. We have substantial standard errors on our estimated effects of Medicaid on the private price, so the Medicaid results are consistent with any model. Focusing on the remaining two derivatives, their inequality is inconsistent with (2), and a positive effect of Medicare on private price is inconsistent with cost constrained quantity maximization (3) because the Medicare margin relaxes the cost constraint.

More formally, we can reject the polar cases as follows:[11]

- If $\partial P^P/\partial Q^R<\partial P^P/\partial Q^C$ we can reject profit maximization
- If $0<\partial P^P/\partial Q^R$ we can reject quantity maximization

There is no formal test of all of the joint inequalities to distinguish the

[11] Note that there are a series of inequalities implied by (4), in contrast with (2) and (3) above. Point estimates are consistent with (4) and neither of (2) or (3) alone. We focus here on sufficient conditions to reject (2) and (3) which are found to be satisfied at a statistically significant level in our empirical tests.

intermediate case (4) characterized above from the two polar cases (2) and (3). But to the extent that not only are the above sufficient conditions rejected, but estimated derivative results look more like (4) than the two polar cases ((2) and (3)), we will have more confidence that our tests and model are 'reasonable.'[12]

Other subjective validity tests are whether the estimated prices exhibit the known relationship $\hat{P}^P > \hat{P}^R > \hat{P}^D$ and whether their magnitudes look to be consistent with expectations given exogenous information from other sources.

Two final points about testable implications should be noted. First, as noted by Lynk (1995), one cannot test NFP behavior by looking at price–cost margins. For NFPs, rent extraction occurs in the form of cost elevation. A 'profit maximizing' NFP captured by administrators may elevate administrative salaries and perquisites; one captured by physicians may inflate medical charges and have perquisites hidden in a variety of cost categories. Our tests are robust to how rents may be extracted from the NFP if it acts as a profit maximizer.

Second, there is a crucial difference between patient shares and patient quantities. To see this, return to the pure quantity maximizing hospital subject to a break-even constraint. Suppose that we consider Medicare patients with reimbursement rates below average costs but above marginal costs. *Additional Medicare patients* will *decrease* the private price, as the added patients will add to net revenues. *Additions to the share of Medicare*, at the expense of private patient caseload, will *increase* the private price, because the increase in share lowers net revenues. Our testing procedure takes both effects into account, but for hypothesis testing focuses on the effect of the change in the total number of Medicare patients, not on their share.

5. The data

The hospitals in the sample include all NFP hospitals in the state of Virginia for which information is available. Information is available for both 1986 and 1987. We have 144 observations in a pooled sample, and 70 observations for which we have both years of data. Estimation will include a pooled regression and two panel regressions (a modified fixed effect specification and a between specification).

The data set does not include information on the revenue breakdown by patient

[12] More rigorously, the null hypothesis to be rejected in each case is equality; inequality in either direction would lead to rejection. Hence, we could reject both polar hypotheses if we found the inequalities $\partial P^P/\partial Q^R > \partial P^P/\partial Q^C > 0$. But this result would not be 'intermediate' between the polar cases and would seem to require implausible conditions on partial derivatives of the utility function, in the context of our theoretical discussion. If we had arrived at this result our inclination would be to assume that the underlying theoretical model was poorly specified.

type, specifically for private, noncharity patients. The data do, however, contain hospital (net) revenues that are not broken down by patient category. By applying latent variable estimation these net revenue data permit us to estimate each price as a function of exogenous information. A description of the variables used in the analysis and of their sources is provided in Table 1. Each individual variable will be defined at the time it is introduced in the description of our regression.

6. The empirical methodology

We want to measure the effect of increases in the number of nonprivate patients on the private price. While private price data for Virginia are unavailable, we have data on each hospital's total net revenue per patient day, TRPD: total of revenues from all patients (and their insurance providers) divided by total patient days for year *t*.

In this section we first develop the methodology which is applied to the pooled sample regressions. As noted earlier, pooled estimation is supplemented by, and justified by, a series of (modified) panel estimation techniques. After the pooled model estimation is presented we discuss the panel techniques, and how they alter the pooled model.

Define P^{τ} as the 'net price' (revenue per patient day) for patients of type τ (with $P^{C}=0$) and s^{τ} as the fraction, or share, of patient days of type τ patients. Then we can write total net revenue per patient day as the weighted average:

$$\mathrm{TRPD} \equiv \sum_{\tau} P^{\tau} * s^{\tau} \tag{5}$$

The empirical hypotheses of Section 4 can be tested by analyzing the net private (noncharity) price per patient day, P^{P}, as a function of the numbers of Medicare, Medicaid and charity patient days: Q^{D}, Q^{R} and Q^{C}. The theoretical discussion assumed that all patients of a single hospital receive the same medical treatment, but did not imply that all hospitals have identical severity of case mix. We need to control for the case and service mixes of the hospital when empirically examining the variation in P^{P}.

We can estimate the individual prices without individual price data. First, suppose that we had the price data and could estimate a reduced form price equation for each patient category. Then define the regression:

$$\begin{aligned} \mathrm{TRPD} &= P^{R} * smr + P^{D} * smd + P^{P} * spi + \eta \\ &= (\alpha X + \epsilon^{R}) * smr + (\beta Y + \epsilon^{D}) * smd + (\gamma Z + \epsilon^{P}) * spi + \eta \end{aligned} \tag{6}$$

where *smr*, *smd* and *spi* are the hospital's share of Medicare, Medicaid and private (paying) patients, respectively. This is the form of our estimating equation. The regressors of the final estimating equation consist of the sum of all the exogenous variables affecting each unobservable patient category price interacted with the

Table 1
Description and variables[a]

Variable	Definition	Source[b]	Mean	S.D.
BEDS	Number of staffed beds	AHA Ann Survey	214	175
CSMX	Case mix index	HCFA Federal Register	1.137	0.117
DTHPCP	County deaths per capita, 1984	ARF 1988	0.009	0.002
GOV	Dummy = 1 if a government facility	AHA Ann Survey	0.056	0.230
INC	County per capita income, 1984	ARF 1988	11 982	3222
MDPCAP	County MD's per capita, 1986	ARF 1988	0.002	0.0018
MNGD	Dummy = 1 if hospital is contract managed	AHA Ann Survey	0.222	0.417
NHBDPC	County nursing home beds per capita	ARF 1988	0.0075	0.0040
OPVOL	Outpatient volume as fraction of revenue	VHSCRC	21.49	5.85
PCTICU	Percent intensive care unit days	AHA Ann Survey	6.88	4.33
PCTOB	Percent of bed in obstetrics and gynecology	AHA Ann Survey	8.10	4.83
PCTWHT	County percent white population, 1982	ARF 1988	78.11	15.70
POPNMR	County non Medicare enrollees population, 1986 (in hundreds)	ARF 1988	143 433	157 512
QCH	Gross unpaid book charges, charity and bad debt, adjusted to days by dividing by TRPD	VHSCRC	4885	11 589
QMD	Total Medicaid inpatient days	AHA Ann Survey, 1988 AHA Guide and VHSCRC	4324	5740
QMR	Total Medicare inpatient days	AHA Ann Survey, 1988 AHA Guide and VHSCRC	22 949	18 405
TEACH	Dummy = 1 for teaching hospital	AHA Ann Survey	0.042	0.201
TRPD	Total net revenues per patient day	VHSCRC	418	97
UR	County unemployment rate	ARF 1988	6.91	3.83
URBAN	Dummy = 1 if urban	HCFA Federal Register	0.56	0.50
WAGE	Total payroll/total FTE personnel	AHA Ann Survey	5613	1024
YEAR	Dummy = 1 if 1986		0.506	0.502

[a] Unless otherwise specified, the variables are for 1986 and 1987. Monetary values are deflated by the monthly CPI (taking into consideration differences between the beginnings of hospital fiscal years).

[b] Abbreviation codes: ARF means Area Resource File; VHSCRC means Virginia Health Services Cost Review Council; AHA Ann Survey means American Association Annual Survey of Hospitals.

fraction, or share, of that particular patient category (noting no contribution or terms from charity patients). Each price is estimated as a latent variable from a single estimating equation.

In (6) there are four error terms. The ϵ^R is, for example, the error term one would expect if one had the data required to run the regression $P^R = \alpha X + \epsilon^R$; similarly for ϵ^D and ϵ^P. The η is, essentially, the 'measurement error' in TRPD.

Eq. (6) is estimated via least squares estimation but an adjustment has been made to correct for the fact that the error term of (6) is heteroskedastic and there is no clear basis for specifying a functional form for the heteroskedasticity.[13] To correct for the unknown form of the heteroskedasticity, we apply White's (1980) consistent estimator of the covariance matrix.

Next we introduce the regressors for each of the price latent variables.

6.1. The Medicare price

For Medicare patients, the choice of the exogenous regressors is determined by the formula the government uses for reimbursement. A key aspect is that hospitals are paid based on DRGs (diagnostic related groups) or diagnoses of their Medicare patients.

Each DRG can be assigned an input intensity level. Medicare reports the average hospital DRG-based input intensity level for Medicare patients as case mix, CSMX. Reimbursement levels are linear in case mix, but the linear formula varies by year and whether a hospital is urban; YEAR and URBAN are dummy variables.[14] We model Medicare reimbursement per patient day[15] as:

$$\begin{aligned} P^R = {} & \alpha_0 \mathrm{CSMX} + \alpha_1 \mathrm{URBAN{*}CSMX} + \alpha_2 \mathrm{YEAR{*}CSMX} \\ & + \alpha_3 \mathrm{URBAN{*}YEAR{*}CSMX} + \epsilon^R \end{aligned} \tag{7}$$

[13] Heteroskedasticity arises from several sources. First, the error term of our estimating Eq. (6) consists of the sum of error terms of the reduced form patient category prices interacted with patient category fractions and the white noise η. Second, Medicare changed the fraction of hospital reimbursement that is hospital-specific over the 2 years. The hospital-specific component is in the error structure. In addition, the complicated structures of Medicare and Medicaid reimbursements suggest that, within a year, there may be heteroskedasticity. These will generate an overall heteroskedastic error structure of unknown functional form.

[14] Some lesser factors also affect Medicare reimbursement. Information on Medicare reimbursement is in Congress of the United States, Congressional Budget Office, August 1988 and US House of Representatives, Committee on Ways and Means, March 3, 1986 and March 6, 1987. Details about the regressors and the institutional reason for the interactions in the Medicare equation are in Deneffe (1990). Note, the formula implies no 'intercept,' fixed payment, in the Medicare price equation (Reimbursement only occurs if the case mix variable takes on a positive value).

[15] The reimbursements are for patient DRGs, not patient days. We model the determinants of the Medicare price per patient day as being the same as the determinants of Medicare DRG based payments.

6.2. The Medicaid price

The State of Virginia Medicaid system does not reimburse by DRG. The reimbursement is based on a hospital's 'allowable' prospective operating costs. The reimbursement depends on hospital size (the number of staffed beds, BEDS), and whether the hospital is urban.[16] The most reasonable exogenous proxy for the hospital allowable cost is the hospital real wage rate, WAGE. The basic specification for the Medicaid price equation is thus:

$$P^D = \beta_0 + \beta_1 \text{URBAN} + \beta_2 \text{WAGE} + \beta_3 \text{BEDS} + \epsilon^D \tag{8}$$

6.3. The private price

The reduced form equation for the private price (total revenue from private patients divided by the number of private patient days) includes all demand side and supply side variables that are assumed to determine the hospital's optimal price per patient day. The crucial variables for our empirical tests will be the quantity of Medicare [QMR], Medicaid [QMD], and charity [QCH] patient days.

The price latent variable is treated as a reduced form equation. Supply and demand variables should capture differences in the case and service mixes, differences in production efficiencies across hospitals, differences in input prices, differences in demographics and the like.[17]

Three variables are included to control for the case and service mixes: (i) CSMX, the relative costliness of the hospital's *Medicare* cases; (ii) PCTOB, the percentage of staffed beds allocated to obstetrics and gynecology; and (iii) PCTICU, the percent of total inpatient days composed of patient days in the Intensive Care Unit. These proxies are good but not perfect. Although case mix is clearly a determinant of price, one would ideally have the private patient case mix. The Medicare case mix, CSMX, may differ from the private case mix. For example, Medicare case mix is dominated by heart disease, while obstetrics can easily comprise 10% of the private patients but is limited in the aging population covered by Medicare. Since obstetrics is generally less costly than other hospital use, we also use PCTOB as a private case mix variable and expect a lower average

[16] See, Commerce Clearing House Inc. (1988). To a lesser extent reimbursement depends upon Medicaid utilization rates (if above 8 percent) and the extent of neonatal care. These lesser factors are not included in our tests.

[17] We do not include concentration ratios. Studies on concentration and NFP hospital pricing have found no concentration effect or a negative effect (cf. Lynk, 1995). When we include concentration we lose 10% of our sample for which concentration is unavailable, and its effect is negative and insignificant.

price when there is more obstetrics.[18] Hence, PCTOB provides an additional control for hospital-wide case mix variation not captured by CSMX. PCTICU is included to capture high cost patient care (but pools Medicare, Medicaid and charity with the private patient cases).

Supply side control variables which capture differences in efficiencies across hospitals are size in terms of staffed beds, BEDS; whether the hospital uses a professional management service, MNGD; whether the hospital is a government entity, GOV; and whether the hospital is a teaching facility, TEACH. The number of staffed BEDS is to control for scale economies. MNGD may control for differences in efficiency between hospitals that are contract managed and those that are not. It has also been suggested that contract managed hospitals set higher prices (rent capture by managers, Ermann and Gabel, 1985). GOV controls for efficiency or incentive differences of government hospitals; there are four in the sample. TEACH controls for the higher intensity of care in teaching hospitals; there are three in the sample. Finally, we control for differences in input prices by using hospital real WAGE.[19]

Factors that affect the demand for hospital services include demographic variables. POPNMR is the number of people in the county who are not Medicare enrollees; NHBDPC is county nursing home beds per capita, an available substitute for some hospital services. Given the importance that the health economics literature has attached to 'supplier/physician-induced demand' for hospital services (e.g. Cromwell and Mitchell, 1986), the number of medical doctors per capita in the county (MDPCAP) is also included. Other demand side variables include UR, the unemployment rate; INC, county per capita income; DTHPC, county deaths per capita as a measure of the health status of the population; and PCTWHT, the percentage of the population that is white (which is generally correlated with higher intensity of use and higher prices; cf. Lynk, 1995).

We also include OPVOL, the percent of outpatient services as a fraction of total services (measured in terms of net revenue). The data are meant to represent inpatient revenues, but rely on accounting conventions to adjust total revenues to obtain inpatient revenues. OPVOL will control for any bias from this procedure. The variables are defined more fully in Table 1.

The basic private price regression is thus:

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[18] See, for instance, Noether (1988) who states that maternity visits tend to be relatively low cost. Note that extensive neonatal care (e.g. significantly premature birth) is relatively expensive but rare. Also note that this will include Medicaid and charity cases as well as private cases. But since Medicaid and charity are small relative to the private case load (see data discussion below), PCTOB is a good proxy for private patient case mix.

[19] It has been said that hospitals have some monopsony control over nurses' wages (Booton and Lane, 1985). To the extent that monopsony differences for nurses are a small fraction of the differences between locations regarding total employee wage differences, the monopsony effect may be ignored.

$$\begin{aligned}P^P = {} & \gamma_0 + \gamma_1\mathrm{CSMX} + \gamma_2\mathrm{PCTOB} + \gamma_3\mathrm{PCTICU} + \gamma_4\mathrm{BEDS} + \gamma_5\mathrm{MNGD} + \gamma_6\mathrm{GOV}\\ & + \gamma_7\mathrm{TEACH} + \gamma_8\mathrm{WAGE} + \gamma_9\mathrm{POPNMR} + \gamma_{10}\mathrm{NHBDPC} + \gamma_{11}\mathrm{MDPCAP}\\ & + \gamma_{12}\mathrm{UR} + \gamma_{13}\mathrm{INC} + \gamma_{14}\mathrm{DTHPC} + \gamma_{15}\mathrm{PCTWHT} + \gamma_{16}\mathrm{OPVOL}\\ & + \gamma_{17}\mathbf{QMR} + \gamma_{18}\mathbf{QMD} + \gamma_{19}\mathbf{QCH} + \epsilon^P \end{aligned} \tag{9}$$

6.4. The empirical model

Substituting Eqs. (7), (8) and (9) into (6), and suppressing the time and hospital subscripts, we obtain the final estimating equation with TRPD as the dependent variable:

$$\begin{aligned}\mathrm{TRPD} &= \hat{P}^R * smr + P^D * smd + \hat{P}^P * spi + \eta\\ &= (\hat{\alpha}X)*smr + (\hat{\beta}Y)*smd + (\hat{\gamma}Z)*spi + \eta'\end{aligned} \tag{10}$$

where *smr*, *smd* and *spi* are the hospital's share of Medicare, Medicaid and private patients in its total patient load; the P^R, P^D and P^P represent the price Eqs. (7), (8) and (9), as does the second equality, which emphasizes that there are parameters to be estimated based upon the explanatory variables of the Medicare price, X, those of the Medicaid price, Y, and those of the private price, Z.[20]

We have two consecutive years of data for 70 hospitals (and one year of data for four hospitals). These data can be analyzed using panel techniques or they can be pooled. If one finds that crucial point estimates are robust to fixed effect estimation, between estimation, and pooled estimation, then the potential for hospital-specific excluded variable bias can be deemed minimal. In this case pooled regression will make the most efficient use of the available data. For our model, the three estimation techniques generate similar parameter estimates. We therefore focus our discussion on the pooled model results. We do present the panel estimates of the crucial parameters below and explain in detail in Appendix B the panel estimation techniques we use.

We should note that the regressors contain a possibly endogenous component. All of the regressors consist of exogenous variables interacted with patient category share variables. The latter may have an endogenous component since each category share contains the private quantity in its denominator. For empirical implementation the logic of the Hausman test is applicable: the issue is not whether there is endogeneity, but whether the endogenous variation is small relative to the exogenous variation. We assume that the exogenous component of the regressors is much larger than the endogenous component and treat the regressors as exogenous variables. For example, the share of charity patients in our

[20] Recall from Eq. (6) that each price equation has an separate error term. Therefore, $\eta' = \eta + \epsilon^R * smr + \epsilon^D * smd + \epsilon^P * spi$.

sample averaged 7 percent, with a minimum and maximum of 0 and 35 percent. This wide variation suggests that mostly exogenous factors are influencing charity care (see Table 1). This assumption is also consistent with convention in the literature (e.g. Hoerger, 1991; Lynk, 1995).

Likewise the patient category quantity variables in the private price may have an endogenous component. A priori one would believe that this component is most pronounced for the charity variable. The same reasoning applies to the possible endogenous variation in the Medicare and Medicaid variables. Endogenous variation should be relatively small, as care for Medicare (and generally Medicaid) patients is reimbursed at or above marginal cost and patient dumping of uninsured emergency patients is illegal. The observed variation in these variables (Table 1) corroborates our belief that exogenous differences dominate (We have insufficient data to test this assumption via the Hausman test; to perform a Hausman test, we would need to observe the actual private price at least).

7. Results

We start with the pooled model results. Eq. (10) was estimated using least squares and White's (1980) consistent estimator of the covariance matrix to correct for heteroskedasticity of unknown form. We present each 'price equation' separately, even though there was a single joint estimation.

The regression performs very well overall. The adjusted R^2 was 0.64. It should be noted that there is some question about how to interpret an R^2 when a regression has no intercept term. As a cross check, we ran the same pooled model with an intercept term. We find that the intercept has a *t*-value of only 0.009, which suggests our specification with no intercept is indeed correct. For this model with an intercept term the adjusted R^2 is 0.63, suggesting that the value of 0.64 which we calculated can be interpreted, as usual, as the percent of variation explained by the model.

In what follows we briefly discuss each 'reduced form' price equation, then focus specifically on the hypotheses about behavior related to the coefficients on QMR, QMD and QCH and on the estimates of prices that are implied by our estimation.

7.1. Medicare reduced form

The Medicare reduced form estimates are

$$\hat{\mathrm{P}}^{\mathrm{R}} = \underset{(8.42^{***})}{286.6} {*}\mathrm{CSMX} - \underset{(1.25)}{46.9} {*}\mathrm{URBAN}{*}\mathrm{CSMX} + \underset{(0.61)}{13.8} {*}\mathrm{YEAR}{*}\mathrm{CSMX} + \underset{(0.58)}{19.4} {*}\mathrm{URBAN}{*}\mathrm{YEAR}{*}\mathrm{CSMX}$$

where here, and below, t-statistics from the White consistent standard errors are in parentheses.[21]

Since several hypotheses are without a priori sign restrictions, we include asterisks indicating the two-tailed significance of each t-value, with three asterisks denoting significance at the 1% level, two indicating significance at the 5% level and a single asterisk denoting significance at the 10% level.[22]

The Medicare institutional price-setting mechanism suggests that case mix is the primary determinant of Medicare prices, and CSMX is highly significant.

7.2. Medicaid reduced form

The Medicaid formula for the State of Virginia is estimated as:

$$\hat{P}^{D} = \underset{(0.92)}{-490.0} + \underset{(0.66)}{113.3}{*}\mathrm{URBAN} + \underset{(2.01^{**})}{0.187}{*}\mathrm{WAGE} - \underset{(0.82)}{1.52}{*}\mathrm{BEDS}$$

The ‘allowable costs’ adjustment factor, WAGE, plays the primary role in the Medicaid formula for the State of Virginia and in these estimates.

7.3. Private price reduced form

This reduced form is the focus of our analysis. The set of explanatory variables is large, reflecting the fact that this price is not set by a simple formula. We have included several potential determinants of price from both the demand and supply side. The estimated relationship is:

$$\begin{aligned}\hat{P}^{P} = {} & \underset{(1.16)}{490.0} - \underset{(0.44)}{133.4}{*}\mathrm{CSMX} - \underset{(4.13^{***})}{13.3}{*}\mathrm{PCTOB} + \underset{(1.74^{*})}{5.92}{*}\mathrm{PCTICU} - \underset{(2.15^{**})}{0.84}{*}\mathrm{BEDS} \\ & + \underset{(1.07)}{42.6}{*}\mathrm{MNGD} + \underset{(2.00^{**})}{101.2}{*}\mathrm{GOV} + \underset{(2.07^{**})}{226.0}{*}\mathrm{TEACH} + \underset{(0.48)}{0.018}{*}\mathrm{WAGE} \\ & + \underset{(3.55^{***})}{0.000512}{*}\mathrm{POPNMR} + \underset{(3.21^{***})}{14197.0}{*}\mathrm{NHBDPC} + \underset{(1.14)}{12076.0}{*}\mathrm{MDPCAP} \\ & + \underset{(2.80^{***})}{18.3}{*}\mathrm{UR} + \underset{(0.12)}{0.0008}{*}\mathrm{INC} - \underset{(3.98^{***})}{35851.0}{*}\mathrm{DTHPC} + \underset{(0.15)}{0.213}{*}\mathrm{PCTWHT} \\ & + \underset{(2.80^{***})}{7.97}{*}\mathrm{OPVOL} \\ & + \boldsymbol{\underset{(2.39^{**})}{0.0068}{*}\mathrm{QMR} - \underset{(0.13)}{0.0015}{*}\mathrm{QMD} + \underset{(3.11^{***})}{0.0193}{*}\mathrm{QCH}}\end{aligned}$$

We first discuss the control variables and then move to the variables of primary interest for hypothesis testing, the patient quantity variables.

[21] We follow a standard convention of calling the estimated coefficient divided by its estimated standard error a t-statistic even when this is not formally from a t-distribution. When using White’s (1980) standard errors the t-statistic is distributed asymptotically standard normal.

[22] We opted to leave insignificant variables in our regression. All variables were included for a priori reasons. Given this, we do not wish to risk excluded variable bias in our key parameters of interest.

7.3.1. The control variables

The first three variables are case mix proxies designed to capture the degree of difficulty of the private patient care caseload. The first of these, the Medicare patient case mix (CSMX) is highly insignificant (and even had the wrong sign). It may well be that, once other factors are taken into account, the difference in the aging population and the private paying population simply means that the degree of difficulty differs across these two patient categories. The other two proxies are of the expected sign and significant. Obstetric work is typically more routine and less expensive, and the sign on PCTOB is negative and significant at the 1% level.[23] The percent of intensive care unit days is positive as expected and significant at the 5% level (on a one-tailed test, since its sign is a priori expected to be positive).

Next are the supply side control variables. The first of these is size, measured by staffed BEDS. This is meant to capture scale economies, as it is generally thought that larger hospitals, ceteris paribus, will face lower unit costs. As expected, this is negative and significant. Next are three hospital type dummies. The hospital category captured in the intercept is a (religious or community) NFP hospital with self management and no teaching school affiliation. It is generally thought that externally managed hospitals, MNGD, will have higher prices as managerial companies may capture some rents (a management company need not be NFP to manage a NFP hospital). The point estimate suggests this may be true, but the effect is insignificant. Second, we distinguish government hospitals, GOV. Government hospitals charge higher prices to private patients.[24] Finally, teaching hospitals (TEACH) are generally expected to have higher costs and a premium reputation.[25] TEACH is positive and significant in explaining the private price. The final supply side control variable is the real wage rate, WAGE. Despite its

[23] The point estimate is high. If this proxy is taken literally to represent only obstetrics, this would imply that obstetrics days cost only about a third of the price of other inpatient days. But more generally, one would expect that hospitals with high birth rates (up to almost half of private patient days in the sample), as contrasted with those with virtually nil birth rates, probably are facing a younger population. With this and other potential correlates for this proxy, it is unrealistic to take PCTOB as solely capturing the lower costs of births.

[24] Lynk (1995) finds that government hospitals have lower prices. This may reflect entirely different circumstances in California (e.g. government subsidies to operating budgets may differ across states). It may also reflect that he measures private price as the average payment of paying patients and charity patients (and government hospitals have a larger proportion of charity cases).

[25] Lynk (1995) mentions these hypotheses, yet finds no higher price for teaching hospitals (In fact for list price he has a higher price, with a $t = 1.41$, significant at the 10% level). His negative point estimates for 'net price' probably reflect significantly greater charity case mix, as his price averages charity and private paying patients. For our sample the three teaching hospitals had charity equal to 41% of all nongovernment patients, whereas for the remainder of the sample charity was only 13% of nongovernment patients.

significant influence on the Medicaid price via a regulatory dependence on local wage rates, it has little influence on the estimated private price.[26]

The next set of control variables captures mostly demand effects. The first of these is the non Medicare population, POPNMR, which includes not only the private paying population but also potential charity and Medicaid patients. Since the number of private patients far exceeds the total of these other two categories, we consider POPNMR to be a reasonable proxy for potential private patient case load. This demand proxy is positive and significant at the 1% level. Next is nursing home beds per capita, NHBDPC. This was included as a possible substitute for hospital services. But rather than having a negative sign, as might be expected for a substitute, it has a positive sign and is significant at the 1% level. The positive sign can only be speculated about. It may show a community's reliance on institutionalized paid medical care, versus in-home care, possibly signaling a form of ability or willingness to pay for inpatient care. But, such ex post logic can be misleading.

MDPCAP, the number of physicians per capita is included because one hypothesis is that when there are numerous physicians they prescribe more medical procedures to maintain their income. Although positive, this variable is insignificant. The unemployment rate, UR, is used as a measure of economic health, holding per capita income constant. Higher unemployment may affect things in a variety of ways. It could lower demand, as expensive medical procedures get delayed until money is available. It could raise demand, as a worker may have time between jobs. Further it may raise demand through the effects of stress and even alcohol abuse. Here unemployment has a positive effect on price which is significant at the 1% level. Since the unemployment rate is positive and significant at the 1% level, its effect here may capture the effects of unemployment on higher demand or on greater expected (future) need for charity care. Per capita income, INC, serves the standard sort of wealth hypotheses, higher demand with higher income.[27] We find no effect of income on the private price.[28]

The death rate per capita, DTHPC, was inserted as a measure of the health of the community. What measure of health is unclear, as it may reflect the death rate in the elderly Medicare population and hence something about the cost of those

[26] Note that to the extent that the State sets its price using a wage index this effect may be expected even if wages, as measured, have little to do with actual hospital marginal costs.

[27] Note that higher wealth may mean demand for more expensive amenities. Also, although not explicitly in our theory, a 'Robin Hood' effect (stealing from the rich to give to the poor) might put less utility weight on expanding the flow of rich (private quantity) through the hospital.

[28] Although Lynk (1995) finds a positive effect, the charity effect may explain this. Higher income areas may have fewer charity cases and his price measure would be lower where there is more charity care.

nonprivate patients. It is a positive and significant determinant of the private price. The percent white in the population, PCTWHT, was insignificant.[29]

The final control variable, outpatient volume (OPVOL), was included because the data on revenues include total hospital revenues which are then adjusted to subtract an estimate of the outpatient revenues. So OPVOL is inserted to capture any bias introduced by the accounting conventions. The outpatient volume was positive and significant in determining the private price.

7.3.2. The variables of primary interest

The key parameters of interest are those on the Medicare, Medicaid and charity patient quantity variables (QMR, QMD and QCH). As a reminder:

Profit maximization→Equality of the three coefficients with coefficients positive if $C'' > 0$

Quantity (Welfare) maximization→

(1) A positive effect of charity quantity on private price
(2) Negative effects of Medicare and Medicaid quantities on price
(3) Medicare effect more negative than Medicaid effect

Intermediate goals (might)→The charity effect is positive and larger than the Medicaid effect which is larger than the Medicare effect, with positive effects *possible* for the latter two if $C''>0$

First, as the regression results show, the point estimate of the effect of Medicaid on the private price is negative but the standard error is substantial. From the White covariance matrix the asymptotic standard deviation is 0.02, so both the Medicare and the charity coefficients are within one standard deviation of the Medicaid point estimate. As such, we ignore the Medicaid estimate for the rest of the analysis; it could be larger, smaller or between the other two interesting coefficients.[30] The coefficient on charity is positive and greater than that on Medicare, as it should be. A test of profit maximization is whether these two coefficients are equal. Using the White covariance matrix the appropriate test of

[29] In Lynk's (1995) study the percent black is associated with lower prices, which again may be influenced by his inclusion of charity care in his private price.

[30] Our theoretical discussion would imply that the Medicaid effect should be between the Medicare and charity effects. Given the estimates we cannot reject this even though the point estimate is not in this range.

whether the coefficient on charity is equal to that on Medicare is a Wald statistic distributed chi-squared with one degree of freedom, χ^2_1. Equality can be rejected: the $\chi^2_1=4.35$, which is significant at the 5% level. **Profit maximization (present value maximization) can be rejected**.[31] Next, can we accept quantity (welfare) maximization? The answer is 'No,' because for this hypothesis to be satisfied one must have a negative Medicare coefficient. The Medicare point estimate is positive with a White covariance adjusted *t*-statistic of 2.39 which is significant at the 5% level. **Quantity/Welfare maximization can be rejected**. Note that this same sign restriction implies that $C''>0$.

A second check of these hypotheses is whether they are sensitive to pooling across both cross section and time series data. We present results across model specifications in the following table in which the first line is the coefficient, the second is the *t* or Wald statistic, and the third is the probability measure (e.g. $P\leqslant 0.05$ implies 5% significance of the test). Details appear in Appendix B. If the results are consistent across specifications then our assumption that that no significant excluded variable bias is present and our reliance on the pooled results are supported.

Model	Medicare effect	Medicaid effect	Charity effect	Equality of the charity and Medicare coefficients
Pooled	0.007	−0.002	0.019	
	(2.39)	(0.13)	(3.11)	$\chi^2_1=4.35$
	$p=0.017$	$p=0.900$	$p=0.002$	$p=0.037$
Fixed effect	0.004	−0.012	0.017	
	(1.98)	(1.20)	(2.98)	$\chi^2_1=5.07$
	$p=0.047$	$p=0.231$	$p=0.003$	$p=0.024$
Between	0.007	−0.011	0.022	
	(1.51)	(0.57)	(2.95)	$\chi^2_1=4.01$
	$p=0.130$	$p=0.570$	$p=0.003$	$p=0.045$

Both the fixed effect and the between models have similar coefficients and similar, albeit less strong, test results on each of these three terms. In every case we can reject the hypotheses at the 5% level (at least) that (i) the Medicare effect is zero; (ii) the charity effect is zero; and (iii) the charity and medicare coefficients are equal.

[31] One caveat should be noted. Since the coefficient on charity is about three times that on Medicare, if the marginal cost increase of an additional charity patient is roughly three times that of an additional Medicare patient, we might not reject profit maximization. This magnitude seems implausible; even an assumption that an additional charity day requires more resources than an additional Medicare day seems unlikely.

The next check on the hypothesis of an intermediate goal is 'Are the values 'reasonable'?' The hypothesis that the charity effect exceeds that for Medicaid which is in turn greater than the value for Medicare is consistent with the estimated parameters. As noted in the theoretical section, this seems reasonable. So next, are the estimated prices reasonable? These can be estimated at mean values of the regressors. The average payments received per patient day for all hospitals is $418. The estimated private price is $669 per patient day, for the Medicare price the estimate is $309, and for the Medicaid price, $296 (Note that multiplying each estimate by its patient share leads to recovering the hospital average of $418 per patient day). These estimated prices are consistent with a variety of types of information. Their order is correct: the private price exceeds the Medicare price which exceeds the Medicaid price. The estimated private price of $669 is lower than that found by Lynk (1995),[32] suggesting that it is not implausibly high.

Another rough yardstick comes from the American Hospital Association (AHA) (1992). For 1990 the AHA found that for Medicaid patients, prices were approximately 80% of average costs (for both inpatient and outpatient services). If average revenues of $418 are slightly above average costs, which is plausible, then our estimates are that the Medicaid price is approximately 75% of average costs which is close to these estimates for the US as a whole for a later year. The AHA also found that the Medicare price was about 90% of costs. Finally, without hard data for the United States or Virginia, we know of individual 'managed care' systems that have in recent years negotiated discounts at individual hospitals on the order of 25–35 percent. If our estimate is close to list price, this would imply discounted prices between $433 and $500 if applied to our data.[33] Our estimates are that the Medicare prices are not substantially greater than the Medicaid prices, but we are still in the correct range of what we should expect to find given these crude benchmarks.

Of particular interest are the effects of the number of Medicare, Medicaid and charity patient days on the price per private patient day. The estimated increase in the private price from one more Medicare patient day is 0.677¢ (the coefficient on QMR is reported as 0.0068 above).[34] Applying this to the known average private patient days of 21,304 we have an increase in annual private patient revenue of $143. Hence our estimates suggest that the addition of one more Medicare patient

[32] His estimates are for (1) 1989, 2 years later than ours, (2) California, which may be a higher priced state, and (3) selected patient subsets by diagnosis. His estimate of $892 is higher (calculated from his price per admission divided by his average length of hospital stay).

[33] Note that for our years the discounted patients for managed care (and PPO) were a small part of the total. The observed discounts come from confidential antitrust investigations.

[34] There can be no precise estimate of the change in marginal costs. Under profit maximization and linear demand, a price increase of 0.677¢ would be induced by an increase in MC of 1.33¢ per patient day, a minuscule fraction of actual MC. The elasticity of price with respect to hospital quantity is roughly one half. These all appear to be plausible values.

day will yield revenues of \$452, the sum of that single day's Medicare price and the influence in higher private patient price on annual private patient revenues. As noted earlier, it is generally thought that Medicaid prices are very close to marginal costs. For sake of illustration only, we make the heroic assumption that marginal costs are \$290, just below the estimated Medicaid price of \$296. With the equally strong assumption that the private care MC is the same as the Medicare MC, this would imply an increase in profits of \$162 [\$309 − \$290 + \$143]. If we use instead our Medicare estimate minus one standard deviation, the effect of a private price increase of 0.39¢ leads to \$84 more private revenue; the combined Medicare plus private revenue increase is \$393; and the profit increase is \$103.

The effect on the private price of one more charity patient day is estimated at 1.93¢, or an increase in hospital revenue of \$410. Using the assumption above that charity patient MC is \$290, this would suggest an increase in profits of \$120. If we use instead our estimate minus one standard deviation, the private price increase of 1.31¢ is \$279 more private revenue, and with our heroic assumption on marginal costs, the hospital absorbs a loss of \$11.[35]

From the above, the magnitudes all seem to be plausible.

7.3.3. Other considerations

While there are strong theoretical reasons to include a time-dummy variable in the Medicare price Eq. (7) due to changes in the Medicare reimbursement rules over the 2 years considered, this is not so for the Medicaid and private price Eqs., (8) and (9). Time dummies in these two price equations were insignificant (t-values of 0.59 and 0.09) and the other estimates were stable upon their inclusion, so we do not report these results.

One more comment on goodness of fit was received from a reviewer. [S]he suggested that with such differences in prices that much of the model's explanatory power was potentially coming from the patient shares alone. To examine this in a nested framework we regress TRPD on CSMX**smr*, *smd*, and *spi* as a 'naive specification'. The adjusted R^2 for this was 0.18. The importance of the additional variables for the full specification could then be tested.

With the White covariance matrix, the standard joint F is replaced by a χ^2 test. This test, with 25 degrees of freedom, yields $\chi^2_{25} = 599.91$, significant at over 99.99 percent. Therefore, we reject the null hypothesis that the additional regressors have no explanatory power. The implied 'prices' from the naive regression are unreasonable as well.[36]

[35] The effect of one more Medicaid patient day on private price is estimated at −0.15¢. Not only is the magnitude small, but the variance on this estimate is substantial, so we do not simulate its effects.

[36] E.g., not only was the implied Medicaid price in the naive model greater than the Medicare price, it was more than double that price.

8. Some policy notes

Currently public policy is based to a great extent on the presumption that NFP hospitals act like profit maximizers. In merger analysis, the antitrust authorities address the question of whether a *profit maximizing* 'hypothetical monopolist' would find it profitable to substantially raise prices (e.g. by five percent) for a sustained period of time (e.g. a year) when questioning the legality of a merger, and this standard is not altered when addressing mergers of NFP hospitals. With technological change and overcapacity in the United States, many hospitals are involved in mergers or are closing. When a NFP hospital is considering merger, it may find it most advantageous to do so with a local rival NFP. Merger with a local rival may facilitate the consolidation of some services that are both expensive and underutilized. Merger with a distant NFP has little potential gain. But, acquisition by a FP hospital chain without a local hospital may lead to a potential gain as assets that are unable to earn an unconstrained market value (e.g. set $MR = MC$) may be sold to an entity which is permitted to maximize profits. It is quite possible that in many instances, by assuming that NFPs act like FPs, policy makers prohibit welfare enhancing local NFP mergers and thereby encourage a welfare decreasing acquisition by an FP which indeed maximizes profits.

We noted earlier that many NFPs are being acquired by FP hospitals. Although not dealing directly with hospital conversions to FP status, a recent *Consumer Reports* (Karpatkin, 1996) discusses related changes. It looks at recent proposals to convert not-for-profit medical insurers (variously separately chartered regional Blue Cross plans) to for-profit status. The ability and incentives for such conversions are noted to depend upon the makeup of their boards of directors (which are set by their charters-bylaws); by their charter rules for changes in status; and by State and Federal laws. In some cases individual Board members can make substantial profits by such conversions; in others State laws have essentially either stopped the process or moved the asset values into the public domain.[37] As noted earlier, the Virginia hospitals are in a different environment than other hospitals since laws and structures vary across the United States. But to the extent that Boards of Directors come from local communities, as an example, it seems less likely that the NFPs or their Boards will extract rents as ongoing concerns or in the sales process (unless given no alternative but to sell to a FP).

In the United States, merger law deals with the 'probabilities' of anticompetitive consequences of mergers. This suggests that the focus in not-for-profit hospital mergers should be on the structure of the Board of Directors (as given in the charter, with community membership weighted toward a procompetitive assess-

[37] For a related discussion on NFP hospitals see 'In Hospital Sales, an Overlooked Side Effect,' *The New York Times*, April 27, 1997, p. 1.

ment), the ability of the Board to convert its status (as specified in the charter), and the State laws governing its status. Certainly there should not be the simple application of 'if market shares exceed those that would be proscribed from a merger of widget makers, then one should proscribe such a not-for-profit hospital merger.'

There are several policy directions one could pursue further. One is the effects of changes in Medicare, Medicaid and/or private insurance managed care reimbursement rates on coverage. Our results are consistent with 'cost shifting,' and are especially robust for the proposition that an addition to a NFP hospital's charity case load leads to higher prices for private indemnity insured patients. Lowering taxpayer-financed Medicare payment rates may lead to an offsetting implicit tax via higher prices for indemnity-insured patient care, and hence higher insurance rates. And estimates of gains from expanded managed care in the private sector may suffer from falsely inflated savings if this too leads to higher indemnity insurance prices. Further, recent efforts to curtail welfare coverage in the United States will lead to less Medicaid coverage and more charity care, again with the potential for an implicit tax effect if hospitals are not profit maximizers.

9. Conclusion

This paper has developed an empirical test that is designed to identify some aspects of the objective function of a not-for-profit hospital. As the *number* of Medicare (or Medicaid) patients increases, a social welfare maximizing hospital should lower its private price because reimbursement exceeds marginal costs. As the charity load increases it must raise its private price to break even. For a profit maximizing hospital, the private price may depend upon total capacity utilization, but not upon the mix between the nonprivate patient categories. Our results are inconsistent with either polar interpretation of not-for-profit hospital behavior. They are consistent with an objective function that places positive utility weight upon both social welfare and profits. This is consistent with earlier empirical results in the literature.

Some major antitrust policy decisions are based currently on an implicit assumption that NFP hospitals act as if they were profit (rent) maximizers. This paper suggests that NFP hospitals in Virginia do not maximize profits, which is the same conclusion arrived at by Lynk (1995) in his recent work on California hospitals. The consistency of these findings suggests that there are potential welfare gains from policy makers recognizing this fact. An important step for researchers is to find out the underlying parameters of NFP hospital behavior. For example, NFP hospitals with community-based boards of directors may differ from others. Answers await better data than are currently available.

Acknowledgements

We are indebted to George Jakubson for modeling suggestions; David Eisenstadt and Harriet Komisar for data and institutional information; and Ramsey Shehadeh for programming, editing and general assistance. We also wish to thank Mike Moore for helpful comments and the Fuqua Associates Fund for financial assistance. Three reviewers for this journal contributed useful methodological and editorial suggestions.

Appendix A. The model

The objective function and constraint, in text, are:

$$\begin{aligned} U &= U(\pi, Q^P, Q^R, Q^D, Q^C) \\ &= U\Big([P(Q^P)Q^P + P^R Q^R + P^D Q^D - C(\sum_\tau Q^\tau)], Q^P, Q^R, Q^D, Q^C\Big) \end{aligned} \tag{A.1}$$

There are three cases: (1) profit maximization, (2) quantity (welfare) maximization, or (3) both profits and quantity have positive utility weight.

To simplify we do not use Kuhn–Tucker formally. The only choice variable is Q^P, the quantity of private patients. Either an unconstrained first-order condition or the constraint will determine the equilibrium. For the unconstrained case ($\pi > 0$) the first-order condition is:

$$dU/dQ^P = U_\pi(MR^P - C') + U_P = 0 \tag{A.2}$$

where $MR^P = (dP^P/dQ^P)Q^P + P^P$ is private patient marginal revenue. $U_\pi(MR^P - C')$ is the *marginal profit utility* of an additional private patient (the additional utility from the profits generated by an additional private patient). The U_P is the direct marginal utility of having another private patient.

For comparative statics, we note that the second-order condition is:

$$d^2U/dQ^{P^2} < 0 \tag{A.3}$$

For the unconstrained cases ($\pi > 0$) the comparative static price effects are given by the three total differentials with respect to the other patient quantities, Q^τ ($\tau = R,D,C$):

$$\begin{aligned} dP^P/dQ^\tau = &-(dP^P/dQ^P)\{(MR^P - C')(U_{\pi\pi}(P^\tau - C') + U_{\pi\tau}) - U_\pi C'' \\ &+ U_{\pi P}(P^\tau - C') + U_{P\tau}\}/(d^2U/dQ^{P^2}) \end{aligned} \tag{A.4}$$

We now can draw the empirically testable implications.

Case (1): the profit maximizing hospital

From (A.4)

$$dP^P/dQ^\tau = (dP^P/dQ^P)U_\pi C''/(d^2U/dQ^{P^2}) \geqslant 0 \tag{A.5}$$

as $C'' \geqslant 0$ is immediate from (A.4). Since costs are determined by total quantity the empirical implications are:

$$dP^P/dQ^R = dP^P/dQ^D = dP^P/dQ^C \tag{A.6}$$

Case (2): the quantity (welfare) maximizing hospital

The profit constraint must be binding, so:

$$P^P(Q^P)Q^P + P^RQ^R + P^DQ^D - C(\sum_\tau Q^\tau) = 0 \tag{A.7}$$

Comparative statics come from the total differential:

$$MR^P dQ^P + P^\tau dQ^\tau - C' dQ^P - C' dQ^\tau = 0 \tag{A.8}$$

This simplifies to:

$$dP^P/dQ^\tau = -(dP^P/dQ^P)(P^\tau - C')/(MR^P - C') \tag{A.9}$$

(Note that $MR^P - C' < 0$). The empirically testable implications are as follows: if $P^R > P^D > C' > P^C \equiv 0$, then:

$$dP^P/dQ^R < dP^P/dQ^D < 0 < dP^P/dQ^C \tag{A.10}$$

Case (3): utility from profits and quantity of each patient type

The constraint $\pi \geqslant 0$ may hold with equality if U_π is small relative to U_P. This would imply (A.10) would hold, and is *observationally equivalent* to Case (2); we aggregate this with the above. If $\pi \geqslant 0$ is not binding (A.4) applies and $MR^P - C' < 0$ at the optimum.

As with any utility problem, there are numerous possibilities. To illustrate some more 'natural' implications we look at the strong simplification of additive utility, $U_{xy} = 0$ for all $x \neq y$ (Since this is not a risk model, the additive utility assumption applies to those utility functions for which a positive monotone transformation can convert the function to an additive one, e.g. Cobb–Douglas, Stone–Geary). Other results than those from additivity are plausible, but these provide a reasonable benchmark and enhance our intuition.

The effect of more Medicare patients on the private price depends on the marginal utility of profits and on the marginal cost function. We first discuss the meaning of $dP^P/dQ^R > 0$, as that is our empirical result. With additive separability, a necessary condition for $\partial P^P/\partial Q^R$, given $P^R > C'$, is $C'' > 0$. From (A.4), the cross partial terms drop out so:

$$dP^P/dQ^\tau = -(dP^P/dQ^P)\{(MR^P - C')(U_{\pi\pi}(P^R - C') - U_\pi C''\}/(d^2U/dQ^{P^2}) \tag{A.11}$$

If, for example, $U_{\pi\pi}=0$, the result is immediate. Because $(P^R - C')>0$ an additional Medicare patient will contribute positive profits from the patient plus it will have greater MC and a higher private price. If $U_{\pi\pi}<0$, C'' must be greater to achieve the same result $(MR^P<C')$, establishing this as a necessary condition (given additivity).

The hospital's response is qualitatively similar to that in profit maximizing price discrimination, as can be seen from (A.2). Intuitively, a profit maximizing, discriminating monopolist adjusts private price so the marginal revenue from private patients net of marginal costs $(MR^P - C')$ equals zero. Analogously, for a Case 3 hospital, if the increase in Medicare patients does not affect marginal utility of profits $(U_{\pi R}=0)$ or marginal utility of private patients $(U_{PR}=0)$, then the private price will be adjusted until the difference between the marginal revenue of private patients and marginal cost equals $-U_P/U_\pi$. Thus, the increased Medicare quantity will lead to a higher private price to reestablish condition (A.2).

The effect of additional charity patients is unambiguous. With additive utility an increase in charity patients never leads to a lower private price (if $C''\geq 0$). Either of the following conditions are sufficient for more charity patients to lead to a higher price: (i) $C''>0$ or (ii) $U_{\pi\pi}<0$. Now (A.4) is

$$dP^P/dQ^\tau = -(dP^P/dQ^P)\{(MR^P - C')(U_{\pi\pi}(-C')) - U_\pi C'') + U_{P\tau}\}/(d^2U/dQ^{P^2}) \tag{A.12}$$

That $C''>0$ is sufficient for $U_{\pi\pi}\leq 0$ and that $U_{\pi\pi}<0$ is sufficient for $C''\geq 0$ is immediate. The difference from above is that the term multiplying $U_{\pi\pi}$ above was the positive $(P^R - C')$, where by definition $P^C=0$.

The effect of more Medicaid patients depends upon whether P^D is greater or less than C'. For brevity, looking at (A.11), replacing P^R with P^D, if $U_{\pi\pi}<0$, then $P^R>P^D>0$ implies that the effect of Medicaid on price will be greater (e.g. more positive or less negative) than the effect of Medicare. Indeed, for $U_{\pi\pi}<0$, as $P^R>P^D>P^C=0$, it follows from (A.4) that:

$$dP^P/dQ^R < dP^P/dQ^D < dP^P/dQ^C \tag{A.13}$$

For empirical implementation we make the assumption that $U_{\pi\pi}<0$. For additive utility, strict quasi concavity requires that no more than one second partial be equal to zero and none may be positive. Furthermore, although some profits may be thought of as a cushion or capable of leading to a few amenities, a great deal of profit might lead to negative consequences if it is 'detected' by the community or the taxation authorities. Although not strictly part of the utility function as structured, these arguments all suggest that $U_{\pi\pi}<0$ is a reasonable assumption, and the predictions of $U_{\pi\pi} < 0$ are the ones found in our tests (with a caveat for the wide variance in the estimation of the effect of Medicaid on price).

Appendix B. Panel estimation

Panel estimation of a model which, by the maintained hypothesis, has no constant term presents special problems. A two-period, unbalanced panel also presents specific restrictions for estimation.

We start with the fixed effect model. For a fixed effect model, a single observation for a hospital would provide no information. Therefore, for a 2-year sample an unbalanced panel is inappropriate. Accordingly we estimate this model for only the 70 hospitals for which we have 2 years of data (this deletes only four hospitals from the pooled sample). The basic testing model in (10) has no constant in the sense of normal regression analysis. It does, however, have some prices which in turn may have constants. Suppose that we were to add a hospital-specific constant (i.e. a fixed effect) to the private price part of the testing model. This serves to capture differences in hospitals' demands, costs or utility functions that are not captured in the independent variables.

Then (10), with time and hospital subscripts added for clarity, becomes:

$$\begin{aligned} \mathrm{TRPD}_{\mathrm{it}} &= \mathrm{P}^{\mathrm{R}}_{\mathrm{it}} * smr_{it} + \mathrm{P}^{\mathrm{D}}_{\mathrm{it}} * smd_{it} + \mathrm{P}^{\mathrm{P}}_{\mathrm{it}} * spi_{it} + \eta_{\mathrm{it}} \\ &= (\alpha \mathrm{X}_{\mathrm{it}}) * smr_{it} + (\beta \mathrm{Y}_{\mathrm{it}}) * smd_{it} + (\boldsymbol{\gamma}_{\mathbf{i}} + \gamma \mathrm{Z}_{\mathrm{it}}) * spi_{it} + \eta'_{\mathrm{it}} \end{aligned}$$

where the γ_i is a hospital-specific fixed effect on the private price setting rule **only**. This fixed effect involves, in effect, a slope effect (γ_i is multiplied by *spi* in the regression). It is implemented by (i) adding 70 hospital-specific dummy variables multiplied by the hospital's private patient share (*spi*) for each year; and (ii) deletion of each variable which is hospital specific but not time varying from the private price section of the model (e.g. DTHPC is based on 1984 data only). Note that *spi* is time variant. For this fixed-effect specification, we have 140 observations, 84 parameters and 56 degrees of freedom.

(Conceptually one also could insert a fixed effect into the Medicare and Medicaid prices. But, for example, a fixed effect in the Medicare regression is not justified by the hospital reimbursement scheme used by the federal government. In addition, each such fixed effect uses 70 degrees of freedom, so we can model only one fixed effect at a time).

The between model is a regression of the mean price over time on the means over time of the independent variables. This is estimated using the same balanced sample and variables as in the fixed effect model (excluding the fixed effects, γ_i). The model now has 70 observations, 14 parameters and 56 degrees of freedom.

As noted in text, panel estimation controls for excluded variable bias which may occur due to hospital specific differences which are not captured in the available data. Since all these models (fixed effect, between and pooled) have very similar point estimates of the parameters of interest (see the table in the text), we assume there is no excluded variable bias and emphasize the more efficient pooled model which has 144 observations, 28 parameters and 116 degrees of freedom.

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