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Reimbursement and Investment: Prospective Payment and For-Profit Hospitals' Market Share

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Abstract

This paper studies how the change from retrospective cost-based reimbursement to a prospective payment system shifted hospital investment strategies from quality-enhancing technologies to cost-saving technologies. A consequence of this change was the opportunity for for-profit hospitals to capture a larger share of the market. When all of a patient's treatment costs are paid under a retrospective average cost-based program, not-for-profit hospitals invest only in the quality-enhancing technology. For-profit hospitals have no incentive to invest in either technology. As a result, most patients select not-for-profit hospitals and for-profit hospitals attract only those few patients who have extreme time preference. When hospitals are reimbursed prospectively, however, not-for-profit hospitals invest in both quality-improving and the cost-saving technologies, as do for-profit hospitals, although at lesser amounts. Quality and market shares are more equal under prospective payment, helping to explain the increasing market share of for-profit hospitals as prospective payment has become the norm.

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1. Introduction

This work is motivated by two observations. One is that over the past decade hospitals have become increasingly concerned about cost control, sometimes, it appears, at the expense of investment that would enhance the quality of patient care. The second observation is the significant growth in market share of for-profit hospitals. From 1980 to 2007, the growth of for-profit hospitals among U.S. community hospitals was 5.3%, faster than the 2.7% growth of not-for-profit hospitals. Government hospitals' market share *declined* by 7.8% during this same period, (Table 1). One question to arise from these observations is whether these simultaneous adjustments are coincidental or has the hospital market undergone a fundamental structural change that is responsible for these both adjustments?

The most obvious structural change since 1980 is the shift from retrospective to prospective payment for a large share of patients, starting with those covered by Medicare. This paper provides a theoretical argument that the move to prospective payment is at least partially responsible for shifting the focus of hospital investment from quality-enhancing technologies to cost-saving technologies, and this change has allowed for-profit hospitals to become more competitive in the hospital market.

The source through which reimbursement affects hospital behavior comes from the fact that hospitals, whether for-profit or not-for-profit, can improve their bottom lines either by attracting more patients or by controlling costs. One way to attract patients is with high quality, while investments can serve to increase quality or lower costs or both. How a hospital is reimbursed changes its payoff from each type of investment. If, as we conjecture, the payment system affects investment strategies, it becomes an important tool for quality as well as for cost.

This last point is not particularly novel. Weisbrod (1991) discussed at length about how the payment system affects investment strategies by hospitals, noting that retrospective payment induces the development of quality enhancing technologies, while prospective payment induces the development of cost saving technologies. What is novel, however, in this paper, is how the change in the payment system caused a structural shift leading to a growing market share for for-profit hospitals, increasing mixed competition in hospital markets.

There are three issues relevant to our analysis: how a shift from retrospective to prospective payment changed the investment strategy hospitals follow; the link between payment system and quality; and finally, what all this means for mixed competition between for-profit and not-for-profit hospitals.

There exists an extensive and varied literature on competition between for-profit and not-for-profit hospitals. Gaynor and Town (2012) provide a comprehensive review of the literature on hospital competition. What is relevant for the present paper is competition between hospitals under administratively set prices. Gaynor and Town note that "entire health systems (e.g. the British National Health Service), or sectors of health systems (e.g. the Medicare program in the US)" operate this way, and in such a situation, the currency of competition is "quality" broadly defined. In a market allowing for entry, they show that quality is increasing in the administratively set price, the elasticity of demand with respect to quality and total demand, and decreasing in the marginal cost of quality and quantity, with similar results if hospitals are for-profit or not-for-profit, although equilibrium quality is higher if hospitals are not-for-profit. Their review of empirical studies on quality and hospital competition find ambiguous results, although a majority of such studies finds more competition increases quality. More recently Brekke, Siciliani and Straume (2011) explain the ambiguous empirical results by allowing quality and costs to be complements (for example, when more practice makes for better results) or substitutes (so increasing quality increases per unit cost) and having differing degrees of altruism among hospitals. Herr (2011) finds public welfare and quality can improve if a private hospital drives out a less efficient public hospital.

Gaynor and Town do not directly confront mixed competition. Explanations for why mixed competition can exist fall into two general classes, those predicated on different preferences on the part of consumers of hospital services, and those that are modeled around a shortage of providers with not-for-profit preferences. An example of the first is Friesner and Rosenman (2002). They model two types of consumers – those who are price sensitive and those who, because of insurance or payment by government programs, are not. Both types of consumers also care about quality. In equilibrium, mixed competition results from profit maximizing hospitals catering to the price sensitive consumers, while not-for-profit hospitals, which care about quality and/or quantity as well as profit, cater primarily to those consumers who are not price sensitive. In this framework, for-profit hospitals give a lower quality of care and lower prices than do not-for-profit hospitals. Different types of hospitals exist to better match consumer demand.

Lakdawalla and Philipson (2006) exemplify the second explanation, where mixed competition is possible through a shortage of providers with not-for-profit (profit deviating) preferences. Noting that a preference for output is similar to taking wealth in an alternative for, for-profit hospitals compete with not-for-profit hospitals, which otherwise come to dominate the market, only because there is a shortage of potential providers with profit-deviating preferences.

Preferences may also deviate from profit maximization along a quality dimension, with the result being mixed competition at all levels of quality. At any quality level where demand exceeds the supply from profit deviators, for-profit firms enter and control the market by being the marginal firm. Lakdawalla and Philipson provide a concise review of the empirical literature that supports their conclusions.

Our approach to mixed competition embraces elements of both Lakdawalla and Philipson and Friesner and Rosenman. Like Friesner and Rosenman, we have a duopoly supply facing heterogeneous consumers who differ along relative preferences for quality and the opportunity cost of time; which plays essentially the same role that price sensitivity did in their model. As in Lakdawalla and Philipson, the not-for-profit hospital will dominate the market due to its willingness to accept part of its return in utility rather than money. At the extreme, as in Lakdawalla and Philipson, the for-profit hospital can compete only if the not-for-profit hospital supplies an insufficient level of quality to attract all consumers. At all other times it is heterogeneous consumer preferences that allow the for-profit hospital to compete.

Our contribution to this literature is that we explain how the for-profit firm can better compete under prospective payment systems than under retrospective payment systems, and the increased ability to compete works through a greater investment in both quality and cost technologies. In terms of quality, for-profit firms unambiguously increases quality while not-for-profit firms likely decreases quality when there is a switch from retrospective to prospective payments. This is consistent with Brekke, Siciliani and Straume who conclude that competition should lead to a convergence between the quality at for-profit and not-for-profit hospitals.

Our results are driven by the fact that consumers, all else equal, prefer higher quality health care. The impact of prospective payment on hospital quality is well-studied. Allen and

Gertler (1991) found that DRG type payments cause a distributional loss when compared to retrospective payment, and that government rate setting cannot induce first-best quality for heterogeneous patients. They provide an early review of the literature on how prospective payment might affect quality. More recently Siciliani (2006) shows that a fully prospective payment system may lower quality by inducing more intense treatment than is necessary – in his model patients who would be best served by low-intensity medical treatment get high-intensity surgical treatment because the DRG payment is higher. Selder (2005) finds that if physicians switch from fee-for-service payment capitation would lower the treatment given severely ill patients.

Empirical analyses have focused more on specific treatments. A meta-analysis of RAND Corporation studies on how prospective payment affected the quality of care for a variety of treatments (RAND, 2006) found little or no change in the direct quality of care, although it did find that patients were discharged in poorer conditions after prospective payment was implemented. To the extent that early discharge can be interpreted as lower quality, this is consistent with what we find.

The novel idea in our paper is the avenue for-profit hospitals used to compete when prospective payment is implemented – an increase in both quality improving investments and cost saving investments. Not-for-profit hospitals, on the other hand, invest less in quality improving technology after a switch from retrospective to prospective payment, but more in cost saving technology. With regard to the investment changes, we extend the theoretical analyses of Ma (1994), Selder (2005) and Miraldo (2007) to a competitive environment. All three of these studies assumes a single decision maker (a for-profit firm or a social planner) with a single provider of hospital services and come to the common conclusion that the hospital (or social planner) will invest more in quality under retrospective reimbursement than under prospective payment.

The empirical literature, for the most part, supports this conclusion. Teplensky *et al* (1995) and Hillman and Schwartz (1985) find that the likelihood of adopting new medical technology, in their study MRI, is reduced under prospective payment. Kesteloot (1995) concludes that cost based retrospective reimbursement is more conductive to the rapid adoption and diffusion of quality improving innovations for cancer care, while prospective reimbursement typically favors the introduction of cost reducing technologies. Other studies reaching similar conclusions include Kane and Manoukian (1989), for cochlear implantation and Butler *et al* (1985) for medical intensive care. Although we make no contribution to the empirical evidence our findings are consistent with these results.

2. A Model of Hospital Competition

The market consists of N patients. Each patient demands one unit of medical service. Patients gain utility from higher quality medical service and lose utility as the time spent waiting for treatment increases.[1] Patients' preferences are assumed to be heterogeneous with different relative preferences for quality and waiting time. Each patient chooses between a for-profit hospital (k=f) and a not-for-profit hospital (k=n), hence $k \in (f, n)$. Demand for each hospital given by:

[1] In the analysis we consider the simplest case where prices are exogenous and paid fully by the government. Hence for simplicity and expediency we do not include price as an argument in the demand facing individual providers. A version of the model with endogenous prices is available from the authors. Our waiting time preference plays the same role as travel time in Brekke, Siciliani and Straume (2011) and Herr (2011) and in fact could be construed in exactly the same way – patients will travel for quality only if it is sufficiently different to justify additional travel costs. This would make T exogenous and simplify the model but not change the results.

$$Q_f = N \bullet G\left(q_f - q_n, T\left(q_f - q_n\right)\right) = Ng(q_f - q_n)$$

(1)

$$Q_n = N \bullet \left[1 - G\left(q_f - q_n, T\left(q_f - q_n\right)\right)\right] = N \bullet \left[1 - g(q_f - q_n)\right]$$

where, Q_f and Q_n are demand for the for-profit hospital and the not-for-profit hospital respectively, q_f and q_n are the respective qualities of the two hospitals, and T is waiting time. Because waiting time is itself a function of the quality difference (see the Appendix) the function $G(\bullet,\bullet)$ collapses to $g(\bullet)$ as shown. We assume the total number of patients, N, is fixed; so $g(\bullet)$ is simply the share of patients going to the for-profit hospital. The continuous, twice differentiable function $g(\bullet), g'(\bullet) > 0$ is a monotonic, continuous, twice differentiable function that maps, $(q_f - q_n)$ to the proportion of patients choosing the for-profit hospital. We assume there are always a number of time sensitive patients such that $0 < g(\bullet) < 1$ for any $(q_f - q_n)$ and that licensing requires quality to meet a minimally acceptable standard, $q_{\min} > 0$.

The variable T is waiting time at the for-profit hospital relative to the waiting time at the not-for-profit hospital, and depends on relative demand, hence on the quality difference between the two hospitals. . It is essentially a congestion externality – as a greater share of the patients use the for-profit hospital, the relative waiting time at the for-profit hospital increases. Patient preferences about waiting time are heterogeneous; some people will choose a lower quality hospital in exchange for a shorter waiting time so a hospital may keep patients even if it has lower quality than its competition. Further discussion of the nature of demand, including waiting time, is provided in the Appendix.

3. Hospital investment

As noted, patients choose between the for-profit hospital and the not-for-profit hospital based on relative quality and waiting time. Faced with their respective demand functions, hospitals make investment decisions to either maximize profit (the for-profit hospital) or utility with a non-negative profit constraint (the not-for-profit hospital). Part of each hospital's decision process is how much to invest in a quality enhancing technology, t_{1h}, a cost saving technology, $t_{2h,}$ or a mix of the two. The quality enhancing technology improves the quality of medical care through product innovation, but increases the cost of treatment. In contrast, the cost saving technology reduces the cost of providing health care without changing the level of quality (Ma, 1994 and Miraldo, 2007).

Because the quality of each hospital (and hence the improvement over $q_{\min}$) is determined by its choice of quality-improving technology the quality function for hospital *h* can be written as:

(2)
$$q_k = \begin{cases} q_{\min} & \text{if } t_{1k} = 0 \\ q_k(t_{1k}) & \text{if } t_{1k} > 0 \end{cases}$$

where $q_k(t_{1k})$ is a strictly concave function which achieves a maximum value of $q_{\max}$ when $t_{ik} = t_{1opt}$ as shown in Figure 1. Because of crowding or other inefficiency, the marginal product of quality investment beyond t_{1opt} is negative.

The for-profit hospital's problem is given by:

(3)
$$\underset{t_{1f},t_{2f}}{Max} Q_f(q_f - q_n)\left[\bar{p}_f - c\left(t_{1f}, t_{2f}\right)\right] - r_1 t_{1f} - r_2 t_{2f}$$
$$s.t. \quad t_{1f} \geq 0, t_{2f} \geq 0 \text{ and the demand equations given by (1).}$$

Here $\overline{p}_f$ is the payment the hospital receives per patient, t_{1f} and t_{2f} are the amounts of quality improving and cost saving technology it adopts, and r_1 and r_2 are the respective prices of each type of technology which are strictly positive and assumed exogenous. We assume the for-profit hospital optimizes its technology adoption levels as though the quality of the non-for-profit is a given.[2]

The hospital's unit treatment cost, $c\left(t_{1f}, t_{2f}\right)$. has the following properties; increasing and concave in t_{1f} , decreasing and convex in t_{2f}, the technologies are unrelated to each other with respect to cost, i.e., $\partial^2 c / \partial t_{1f} \partial t_{2f} = 0$, for any $t_{1f} \geq 0$, $c(t_{1f}, t_{2f}) > 0$ (a larger t_{1f} always induces a larger unit treatment cost regardless of t_{2f} ,i.e., $t_{1f} > t_{1f}', t_{2f} \gtreqless t_{2f}' \Rightarrow c(t_{1f}, t_{2f}) > c(t_{1f}', t_{2f}')$ [3]), and zero investment in both technologies induce a positive unit treatment cost, i.e., $c(0,0) = \overline{c} > 0$ where $\overline{c}$ is some constant.[4]

The not-for-profit hospital gains utility from both quality and quantity and faces an objective function to[5]:

$$
\begin{aligned}
&\underset{t_{1n}, t_{2n}}{Max} U\left[Q_n(q_f - q_n), q_n(t_{1n})\right] \\
&s.t.\ \ t_{1n} \geq 0,\ t_{2n} \geq 0 \\
&\quad Q_n(q_f - q_n)\left[\overline{p}_n - c(t_{1n}, t_{2n})\right] - r_1 t_{1n} - r_2 t_{2n} + D\left[Q_n(q_f - q_n), q_n(t_{1n})\right] \geq 0.
\end{aligned} \tag{4}
$$

[2] This is essentially Cournot style competition.

[3] The last property of the unit cost treatment cost function says that the cost saving technology cannot fully offset the cost increasing from the quality enhancing technology.

[4] Investing in t_{2k} pushes $\overline{c}$ lower, but never to negative amounts.

[5] This Newhouse (1970) type utility function is formalized by Sloan (2000). In his model, U=U(X,Y,π) where X =output, Y=quality, and π=profit. In our model, we extract profit from the utility of the not-for-profit hospital, and set it as a non-negative constraint. Hoerger (1991) finds empirical support that the not-for-profit hospital maximizes utility subject to zero profit constraint and Horwitz and Nichols (2009) conclude that the empirical evidence fits best with hospitals that maximize their own output.

We assume the utility of the not-for-profit hospital is non-decreasing and concave in both quantity and quality, i.e., $\partial U / \partial Q_n \geq 0$, $\partial U / \partial q_n \geq 0$, $\partial^2 U / \partial Q_n^{\ 2} \leq 0$, and $\partial^2 U / \partial q_n^{\ 2} \geq 0$, but at least one satisfies an inequality condition for the strict monotonicity of the not-for-profit hospital's preference, i.e., $\partial U / \partial Q_n > 0$ or $\partial U / \partial q_n > 0$. The not-for-profit hospital also optimizes its technologies adoption levels as if the quality of the for-profit hospital is given. The properties of the quality function and the unit treatment cost of the not-for-profit hospital are identical with those of the for-profit hospital.

Besides being paid for services by the government, the not-for-profit hospital can raise money through donations, $D\left[Q_n(q_f - q_n), q_n(t_{1n})\right]$, which depend on hospital quality and the quantity of patients it serves[6]. All the arguments of the donation function are same as those of the utility function of the not-for-profit hospital.[7]

Both hospitals increase their level of quality in order to attract patients by increasing t_{1h}; however $c(t_{1h}, t_{2h})$ increases as well. The cost saving technology t_{2h} decreases only the unit treatment cost.

3.1 Retrospective reimbursement of average cost

Suppose hospitals are reimbursed retrospectively based on average total cost. Then the respective per unit revenues are $\overline{p}_f = c(t_{1f}, t_{2f}) + \frac{r_1 t_{1f} + r_2 t_{2f}}{Q_f(t_{1f})}$ and $\overline{p}_n = c(t_{1n}, t_{2n}) + \frac{r_1 t_{1n} + r_2 t_{2n}}{Q_n(t_{1n})}$. By definition the for-

---

[6] One of the differential characteristics of not-for-profit enterprises is its ability to attract charitable donations. Even if there were tax advantages for donating to for-profit enterprise, few donors would do so because they would simply be enriching the for-profit firm's shareholders (Hansmann, 1980, 1998 and Sloan, 2000). Although the potential for donations would seem to be a big advantage for not-for-profit hospitals, in recent years, donations have become a relatively unimportant source of revenue for not-for-profit hospitals. In 1983, only 0.4% of revenue is derived from the donations. One of the reasons for the decline is thought as the growth of the health care insurance (Sloan, 2000).

[7] The money constraint of the not-for-profit hospital can be decomposed as the profit part $(Q_n(q_f - q_n)\left[p_n - c(t_{1n}, t_{2n})\right] - r_1 t_{1n} - r_2 t_{2n})$ and the donation part ($D\left[Q_n(q_f - q_n), q_n(t_{1n})\right]$). Because the not-for-profit hospital can raise money by fundraising, it can actually have negative operating revenue as long as the total net revenue is non-negative.

profit hospital earns zero profit. Its optimization problem is degenerate and it has no incentive to invest in either technology. . The not-for-profit hospital has the following problem:

$$
(5)\qquad \begin{aligned} &\underset{t_{1n},t_{2n}}{Max}\, U\left[Q_n(q_f - q_n), q_n(t_{1n})\right] \\ &s.t.\;\; t_{1n} \geq 0,\, t_{2n} \geq 0 \\ &\qquad D\left[Q_n(q_f - q_n), q_n(t_{1n})\right] \geq 0 \end{aligned}
$$

The solution to (5) combined with the degenerate solution to the for-profit hospital leads to Proposition 1:

Proposition 1: *When the government pays the full cost of treatment and hospitals are reimbursed their average total cost, the not-for-profit hospital invests only in quality enhancing technology and obtains the globally maximal level of quality. Meanwhile the for-profit hospital has no incentive to make investments in either type of technology.*

Proof: We add one additional behavioral assumption common to both hospitals, that in the absence of an incentive to make an investment, a hospital chooses not to.[8] With this assumption, neither hospital has an incentive to invest in cost saving technology because doing so will simply lower their payment dollar-for-dollar. Therefore $t_{2f} = 0$ and $t_{2n} = 0$. By the same logic $t_{1f} = 0$ and the quality of the for-profit hospital is given by $q_f(t_{1f} = 0) = q_{\min}$.

Meanwhile, the not-for-profit hospital faces the equivalent of the unconstrained optimization problem $\underset{t_{1n}}{Max}\, U\left[Q_n(q_f - q_n), q_n(t_{1n})\right]$ because retrospective reimbursement ensures

[8] One may motivate this behavior by a minute unreimbursed fixed transactions cost that is incurred whenever a hospital undertakes any investment. When there is no possible return from an investment, the hospital will choose to not do it.

that $Q_n(q_f - q_n)\left[\bar{p}_n - c(t_{1n}, t_{2n})\right] - r_1 t_{1n} - r_2 t_{2n} + D\left[Q_n(q_f - q_n), q_n(t_{1n})\right] \geq 0$ as $t_{2n} = 0$,

$Q_n(q_f - q_n)\left[\bar{p}_n - c(t_{1n}, t_{2n})\right] - r_1 t_{1n} - r_2 t_{2n} = 0$ by definition and $D\left[Q_n(q_f - q_n), q_n(t_{1n})\right] \geq 0$ always.

The first-order condition is $U_{q_n} \frac{\partial q_n}{\partial t_{1n}} + U_{Q_n} \frac{\partial Q}{\partial q_n} \frac{\partial q_n}{\partial t_{1n}} = 0$. By strict monotonicity of the utility function and demand function the condition holds only when $\partial q_n / \partial t_{1n} = 0$ which, as shown in Figure 1, occurs at t_{1opt}. Therefore, $t_{1f} = 0, t_{2f} = 0, t_{1f} = t_{1opt}$, $t_{2f} = 0$. *Q.E.D.*

Corollary 1: *Under retrospective reimbursement* $Q_n > Q_f$.

Proof. Because of the nature of demand (as explained in the Appendix) a higher quality hospital has a larger share of the market. By Proposition 1 $t_{1n} = t_{1opt} > t_{1f} = 0$. *Q.E.D.*

The for-profit hospital has no incentive to invest in either type of technology because at all levels of investment in either technology it makes the same zero profits. At the same time the not-for-profit hospital has an incentive to invest only in quality; it brings two things it wants – higher quality and more quantity while cost savings does nothing to increase its utility. Given these different incentives the not-for-profit hospital will have higher quality than the for-profit hospital, and thus attract a much larger share of patients. Only those patients with extreme preferences for short waiting times will use the for-profit hospital.

In our proof we assume in the absence of an incentive to invest hospitals choose not to, and motivated it with a small fixed unreimbursed transactions cost. Without this assumption multiple equilibria are possible, all but one resulting in the not-for-profit having a higher quality. The one exception is if the for-profit hospital invests also to optimal quality, in which case quality is the same in both hospitals. Which equilibrium arises is an empirical question. While widespread and dependable data on relative quality is difficult to come by, empirical evidence on quantity is readily available. To the extent that quality attracts quantity (as assumed in this model) the data reported in Table 1 would indicate that not-for-profit hospitals provided a higher level of quality than for-profit hospitals under retrospective reimbursement. Just prior to Medicare prospective payment for-profit entities comprised only approximately 13% of all community hospitals. In 1980 for-profit hospitals provided less than 9% of all community hospital beds in the US (Sloan, et al,, 1990).

Chalkley and Malcomson (2000) point out that cost reimbursement provide hospitals no incentive to reduce costs. We show it also provides strong incentives for not-for-profit hospitals to invest in quality. Moreover, because retrospective reimbursements cover all costs, not-for-profit hospitals have little incentive to raise money through donations if bills are paid by the government (or insurance). This latter finding is consistent with Sloan, et al (1990) who found that increased insurance coverage and enactment of Medicare and Medicaid reduced giving to hospitals.

3.2. Prospective reimbursement

In this section we assume both hospitals are reimbursed prospectively, and the prices of both hospitals are identical ($\overline{p} = \overline{p}_f = \overline{p}_n$).[9] Equations (3) and (4) still characterize the problem facing each hospital, with $\overline{p}$ substituting for the respective prices.

[9] Siciliani (2006) argues that hospitals can influence its tariff under prospective payment through treatment choice, thus assuming a fully prospective payment is simplistic, We follow the common assumption of a single lump-sum payment for each patient used by Allen and Gertler (1991), Ma (1994) and over a dozen additional papers cited by Siciliani. Since all our patients are the same, this is an appropriate model for our purposes. Our primary results would hold under different payment amounts to the hospitals, as long as the payment amounts are not endogenous.

Maximizing equation (3) with respect to t_{1f} and t_{2f} the first order conditions for the for-profit hospital are:

(6)
$$\frac{\partial Q_f}{\partial q_f}\cdot\frac{\partial q_f}{\partial t_{1f}}\left(\overline{p}-c_f\right)-Q_f\frac{\partial c}{\partial t_{1f}}-r_1=0$$

(7)
$$-Q_f\frac{\partial c}{\partial t_{2f}}-r_2=0$$

And the first order conditions for the not-for-profit hospital are:

(8)
$$\frac{\partial U}{\partial Q_n}\frac{\partial Q_n}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}}+\frac{\partial U}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}} +\lambda\left[\frac{\partial Q_n}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}}(\overline{p}-c_n)-Q_n\frac{\partial c}{\partial t_{1n}}+\frac{\partial D}{\partial Q_n}\frac{\partial Q_n}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}}+\frac{\partial D}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}}-r_1\right]=0$$

(9)
$$\lambda[-Q_n\frac{\partial c}{\partial t_{2n}}-r_2]=0$$

(10)
$$\lambda\left[Q_n(\overline{p}-c_n)-r_1t_{1n}-r_2t_{2n}+D\left(Q_n,q_n\right)\right]=0,\ \lambda\geq 0$$

where λ is the Lagrangian multiplier on the revenue constraint. From the above first order conditions, we obtain Proposition 3.

Proposition 2 *Under full government payment of patients' costs, when hospitals are reimbursed prospectively the same amounts;*

1. *The for-profit hospital has invests in both technologies but does not reach the globally maximum quality.*
2. *The not-for-profit hospital invests in both technologies if the revenue constraint is binding, but does not reach the globally maximizing quality.*

3. *The not-for-profit hospital invests only in quality technology if the revenue constraint is not binding, and reaches the globally maximum quality.*
4. *If the revenue constraint is binding the not-for-profit hospital invests more in both technologies than does the for-profit hospital.*

.

Proof:

P2.1: From equation (7) we see that the for-profit hospital adopts t_{2f} to the point that $\frac{\partial c}{\partial t_{2f}} = \frac{r_2}{-Q_f}$. From (6) we see that $\frac{\partial Q_f}{\partial q_f} \cdot \frac{\partial q_f}{\partial t_{1f}}\left(\overline{p} - c_f\right) = Q_f \frac{\partial c}{\partial t_{1f}} + r_1 > 0.$ If $t_{1f} = t_{1opt}$ the left-hand-side equals 0 hence, because the right-hand side is strictly positive, we can conclude further that $t_{1f} < t_{1opt}$.

P2.2: Rearrange (9) to

$$\frac{\partial U}{\partial Q_n}\frac{\partial Q_n}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}} + \frac{\partial U}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}} + \lambda\left[\frac{\partial Q_n}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}}(\overline{p} - c_n) + \frac{\partial D}{\partial Q_n}\frac{\partial Q_n}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}} + \frac{\partial D}{\partial q_n}\frac{\partial q_n}{\partial t_{1n}}\right] = \lambda\left[Q_n \frac{\partial c}{\partial t_{1n}} + r\right] \tag{11}$$

The term in brackets on the right-hand-side is positive so if the revenue constraint is binding (i.e., $\lambda > 0$) then $t_{1opt} > t_{1n} > 0$ to ensure that the left-hand-side is also positive. The analysis of t_{2n} follows analogously to the arguments used for t_{2f}. From (9) and $\partial c / \partial t_{2n} < 0$ we see that if the revenue constraint is binding ($\lambda > 0$) the not-for-profit firm invests in cost saving technology until $\frac{\partial c}{\partial t_{2n}} = \frac{r_2}{-Q_n} \Rightarrow t_{2n} > 0.$

P2.3: If $\lambda = 0$ (i.e., the revenue constraint is non-binding) the non-bracketed terms on the left-hand-side of (11) must sum to 0 which is achieved only if $t_{1n} = t_{1opt}$. If $\lambda = 0$ its investment in the cost saving technology is undefined. Because the revenue constraint is not binding the hospital has no incentive to invest in cost saving technology, and by our assumptions will not do so.

P2.4: To show the relative investments, we first look at the investment in quality improving technology. We are concerned only with the case when $\lambda > 0$. We compare

$$(12) \quad \frac{\partial Q_f}{\partial q_f} \cdot \frac{\partial q_f}{\partial t_{1f}} \left(\overline{p} - c_f \right) = Q_f \frac{\partial c}{\partial t_{1f}} + r_1$$

to (11).

We have already showed that $t_{1f} < t_{1opt}$. Rearrange (11) to

$$(13) \quad \frac{1}{\lambda} \left[\frac{\partial U}{\partial Q_n} \frac{\partial Q_n}{\partial q_n} \frac{\partial q_n}{\partial t_{1n}} + \frac{\partial U}{\partial q_n} \frac{\partial q_n}{\partial t_{1n}} \right] + \left[\frac{\partial D}{\partial Q_n} \frac{\partial Q_n}{\partial q_n} \frac{\partial q_n}{\partial t_{1n}} + \frac{\partial D}{\partial q_n} \frac{\partial q_n}{\partial t_{1n}} \right] = Q_n \frac{\partial c}{\partial t_{1n}} + r_1 - \frac{\partial Q_n}{\partial q_n} \frac{\partial q_n}{\partial t_{1n}} (\overline{p} - c_n)$$

The left hand side of (13) is positive hence so is the right hand side. We see from (12) that

$Q_f \frac{\partial c}{\partial t_{1f}} + r_1 - \frac{\partial Q_f}{\partial q_f} \cdot \frac{\partial q_f}{\partial t_{1f}} \left(\overline{p} - c_f \right) = 0$ implying that

$$(14) \quad Q_n \frac{\partial c}{\partial t_{1n}} - \frac{\partial Q_n}{\partial q_n} \frac{\partial q_n}{\partial t_{1n}} (\overline{p} - c_n) > Q_f \frac{\partial c}{\partial t_{1f}} - \frac{\partial Q_f}{\partial q_f} \cdot \frac{\partial q_f}{\partial t_{1f}} \left(\overline{p} - c_f \right).$$

Figure 2 shows that for this inequality to hold $t_{1n} > t_{1f}$ which also means that $Q_n > Q_f$ by virtue of the demand equations.

We have shown in part 1 and 2 that $\frac{\partial c}{\partial t_{2f}} = \frac{-r_2}{Q_f}$ and $\frac{\partial c}{\partial t_{2n}} = \frac{-r_2}{Q_n}$. Since $Q_n > Q_f$ we know that $\frac{\partial c}{\partial t_{2n}} < \frac{\partial c}{\partial t_{2f}}$, i.e., the marginal cost saving for the not-for-profit firm is smaller than the marginal cost saving for the for-profit firm. By the properties of $c(t_{1h}, t_{2h})$ we have $t_{2n} > t_{2f}$.

Q.E.D.

Propositions 2.3 and 2.4 imply that the not-for-profit hospital will have the larger share of patients under prospective payment. According to Sloan (2000), the dominance of the not-for-profit hospital is supported by several arguments such as the transaction costs of ownership; fiduciary relationships and complex output; implicit subsidies; explicit subsidies; inertia; cartel theory; and for-profit entry. Our model explains not-for-profit dominance without relying on any of these factors. We have applied the same production and cost technology to both types of hospitals, removing implicit subsidies as a cause of not-for-profit dominance. Although we have allowed for the opportunity of the not-for-profit hospital to accept explicit subsidies in the form donations, but our results are not dependent on this opportunity.

Corollary 2: *The dominance of the not-for-profit hospital under both retrospective and prospective reimbursement is not due to its ability to raise revenue through donations. They have no effect on market share under retrospective payment. Donations increase the not-for-profit hospital dominance when payment is prospective.*

Proof. Under retrospective payment $t_{1n} = t_{1opt}$ and was not dependent on its ability to raise donations because the revenue constraint is non-binding. Also $t_{1f} = 0$. Thus $q_n = q_{\max}$ and $q_f = q_{\min}$. The quality difference is the largest possible in favor of the not-for-profit hospital which therefore dominates the market regardless of donations raised.

Under prospective reimbursement, if there are no donations, the left-hand-side of (13) is still positive, but smaller. Hence, the inequality given by (14) still holds, but is smaller, so although $t_{1n} > t_{1f}$ still, As a result, however, the quality dominance of the not-for-profit firm is smaller, and while it still has a larger share of the market, it is not as dominant as when donations are positively related to quality. *Q.E.D*

Corollary 2 shows that under prospective payment the more donations the not-for-profit hospital receives, the larger the market share it obtains. As noted earlier, not-for-profit hospitals have become less dependent on charitable giving in recent years. Frank and Salkever (2000) provide data indicating the share of not-for-profit hospital revenues declined from 7.8% to 3.6% from 1977 to 1992. At the same time, for-profit hospitals have gained market share. While this correlation ascribes no causality one way or the other, the outcome is consistent with Corollary 2.

Another critical concern is the comparative amounts of quality enhancing technology adopted by hospitals under different reimbursement systems. Our analysis indicates that the quality of care is generally lower under prospective reimbursement.

Corollary 3

1: *The quality of care given by the not-for-profit hospital under a retrospective reimbursement system exceeds the quality it provides under the prospective payment unless the revenue constraint is non-binding, and its market dominance is stronger.*

2: *The quality of care given by the for-profit hospital under a retrospective reimbursement system is less than the quality it provides under the prospective payment and it better competes for market share.*

Proof

C3.1. Under retrospective payment system $t_{1n}^{r} = t_{1opt}$ where the superscript indicates the investment under the retrospective payment system. Similarly, $t_{1n}^{p} < t_{1opt}$ where now the superscript indicates the investment under prospective payments when the revenue constraint is non-binding. Because the investment in quality is higher under the retrospective system, it has higher quality, and therefore, more market dominance. *Q.E.D.*

C3.2. Under retrospective payment system $t_{1f}^{r} = 0$ where the superscript indicates the investment under the retrospective payment system. Similarly, $t_{1f}^{p} > 0$ where now the superscript indicates the investment under prospective payments. Because the investment in quality is higher under the prospective system, it has higher quality, and therefore, a greater market share. *Q.E.D.*

The implications of Corollary 3 are clear – the move from retrospective payments to prospective payments decreased the market dominance of not-for-profit hospitals.

Our results indicate that the advent of prospective payment in hospital reimbursement had profound impacts, some desired and intended, others not intended and not always welcome. We found, as hoped, that there is more investment in cost saving technology – both for-profit and not-for-profit firms move from no investment in such technology to positive investment, indicating that costs are lower than they would be under retrospective reimbursement for the same quality. The impact on quality, however, is mixed. For-profit firms increase the quality when reimbursement moves from retrospective to prospective, a welcome change. Under most circumstances, however, not-for-profit hospitals decrease their quality with the change in reimbursement. The impact on average quality is unclear. Finally, the change allows for-profit hospitals to compete better, and take a larger share of the market.

4. Conclusions

From its establishment in 1965 until fiscal year 1983 Medicare's hospital costs rose from $3 billion to $37 billion annually. The US Department of Health and Human Services blamed retrospective cost-based payment for this dramatic rise in spending because it provided hospitals incentives to provide more services and invest in costly medical technology (Gottlober, 2001). In 1983 Medicare switched to a prospective payment system to curtail Federal spending on medical services. Proponents hoped this change would motivate hospitals to deliver services with increased efficiency and lowered costs. In this paper we focused on how the change to prospective payment differentially affected for-profit and not-for-profit hospitals investment decisions between quality improving and cost saving technologies and the implications this had on quality and competition.

We find that the switch had the intended results; both types of hospitals invest more in cost-saving technologies, increasing efficiency, but with some probably innocuous (in one case) and potentially negative (in another case) unintended consequences. One seemingly innocuous outcome is that for-profit hospitals are more competitive under a prospective payment system. The potentially negative outcome is that not-for-profit hospitals likely invest less in quality enhancing technology under prospective payments than under retrospective payments. This is only potentially negative because for-profit hospitals increase quality investment with prospective payment. The overall change in average quality is an empirical question and depends on the level of prospective reimbursement provided; prospective payment provides a policy tool to balance between quality-enhancing and cost-saving technologies.

We achieve these outcomes with a novel model that integrates how a shift from retrospective to prospective payment changed the investment strategy hospitals follow, how that affects quality, and what it all means for mixed competition between for-profit and not-for-profit hospitals. Overall our results are consistent with what has been found in the separate strands of literature focusing on each of these issues. For example, like Miraldo (2007) and Ma (1994) we find retrospective cost-based reimbursement provides no incentive to invest in cost-saving technology while prospective payment does provide this incentive and for-profit hospitals invest in quality only with prospective payment. We have no definitive result on average hospital quality, consistent with the ambiguity reported by Gaynor and Town (2012) but like Brekke, Siciliani and Straume (2011) find a convergence of the quality offered by the two types of hospitals. And, again consistent with what is reported in Gaynor and Town, find prospective payment increases the competitiveness in hospital markets.

In what may be the most appropriate comparison, our findings are in concordance with Hirth, Chernew and Orzol (2000) who examined how capitation changed behavior by dialysis units. They found that both for-profit and not-for-profit dialysis units faced with fixed prices responded differently. For-profits invested less in technical quality than did not-for-profit providers, while both types made cost-saving adjustments.

Our paper uses a simple setup which allows us to obtain clear-cut results and to highlight the effects driving the investment choices and subsequent outcomes for quality and competition under each reimbursement system. One important extension would be the case when patients, rather than the government, pay for hospital services, hence price sensitivity matters. In such a case the price charged by the for-profit hospital is always higher than that of the not-for-profit hospital and the not-for-profit hospital adopts more quality enhancing and cost saving technologies implying that in the absence of insurance for-profit hospitals could not effectively compete.[10]

However, our simple model is consistent with the separation a majority of people have in the direct cost of their healthcare. In 2008 approximately 85% of Americans had health insurance, with about two-thirds of the populace covered by private health insurance and 29% covered by government plans.[11] Over 87% of those with private health insurance were covered by policies obtained through employment (Bureau of the Census, 2009). Moreover, in 1992 approximately one-third of private insurers used some form of DRG-based reimbursement (Ellis & McGuire, 1993), indicating that the private insurance market rapidly joined the march towards prospective payment.

[10] This extension is available from the authors.
[11] Coverage is not mutually exclusive. These percentages indicate that approximately 10% of the population has both private health insurance and coverage from a government program.

Appendix: Demand, waiting time and investment in quality

As discussed in the text and shown in figure 1, quality is a concave function of investment in quality. The minimum quality required for licensing is $q_{\min}$. Investment in quality increases the quality of output up to an investment level of t_{1opt}, after which further investment, because of crowding or other inefficiency, lowers quality – for investment beyond t_{1opt} the marginal product of the investment is negative. Hospitals will never invest more than t_{1opt} and the highest possible quality is $q_{\max}$ so the range of quality for each hospital is $[q_{\min}, q_{\max}]$. The difference in hospital quality is $q_f - q_n$ which has a range of $[q_{\min} - q_{max}, q_{\max} - q_{\min}]$ where the lower end is realized if the for-profit hospital chooses $t_{1f} = 0$ and the not-for-profit hospital chooses $t_{1n} = t_{1opt}$ and the upper end is realized if the choices are opposite. We note that if both hospitals choose the same level of quality investment, whatever level is chosen, then the hospital quality difference is 0. Patients choose which hospital to go to by relative quality and waiting time. Waiting time, T_k, at hospital k is a function of the number of patients choosing that hospital. For convenience, we assume waiting time is proportionate to the share of patients choosing each hospital. Individual consumers are attracted to a hospital if its differential quality is positive but repelled if its differential waiting time is positive. As is normal in congestion externalities, all patients ignore their own contribution to congestion, taking Q_k, hence T_k, as fixed, $k = f, n$.

Individual tolerances regarding waiting time are heterogeneous. The following characterization provides an example of how patients choose between relative quality and waiting time. Patient i chooses hospital y over hospital x if $q_y - q_x > \gamma_i$ where $\gamma_i \in [0, q_{\max} - q_{\min} + \varepsilon]$ measures her personal dislike for waiting time – it represents the heterogeneity of preferences about waiting time and relative quality – and ε is a small positive constant. Patients with $\gamma_i = 0$ have a high tolerance for waiting time and will always choose a hospital with higher quality. Those with γ_i near its upper boundary have little tolerance for waiting time and, knowing a quality difference will attract patients to hospital y thus increasing the waiting time at that hospital, will go there only if the quality difference is very large. In fact, such is the disdain for waiting among some patients that they choose the lower quality hospital even if the quality difference is at its extreme value.

Given this behavior, the quality difference provides a metric of the share of patients using each hospital. At the lower end point where $q_f - q_n = q_{\min} - q_{\max}$ almost all patients choose the not-for-profit hospital and only those patients with an extreme dislike of waiting (where γ_i approaches its maximum value) use the for-profit hospital. At the other extreme where $q_f - q_n = q_{\max} - q_{\min}$ most patients choose the for-profit hospital. Only those few patients who truly disdain waiting will go to the not-for-profit hospital – these are the same patients who would choose the for-profit hospital when it had the much lower quality.

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TABLE 1.

Number and Percentage of U.S. Community hospitals by Ownership Type, selected year

Year	Total	For-profit		Not-for-profit		Government	
	Numbers	Numbers	Percentage	Numbers	Percentage	Numbers	Percentage
1975	5,875	775	13.2	3,339	56.8	1,761	30
1980	5,830	730	12.5	3,322	57	1,778	30.5
1985	5,732	805	14	3,349	58.5	1,578	27.5
1990	5,384	749	13.9	3,191	59.3	1,444	26.8
1995	5,194	752	14.5	3,092	59.5	1,350	26
2000	4,915	749	15.2	3,003	61.1	1,163	23.7
2003	4,893	790	16.1	2,984	61	1,121	22.9
2004	4,919	835	17	2,967	60.3	1,117	22.7
2005	4,936	868	17.6	2,958	59.9	1,110	22.5
2007	4,897	873	17.8	2,913	59.5	1,111	22.7

Source: 1975 to 2005 data; James W. Henderson, Health Economics and Policy 4th Edition, p270.

2007 data; American Health Association Resource Center

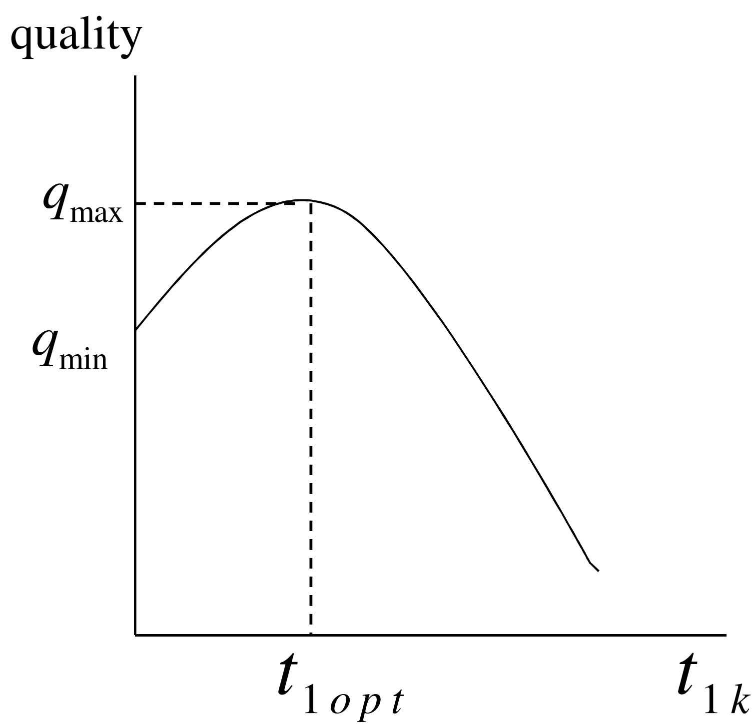

Figure 1
Quality and Quality Investment

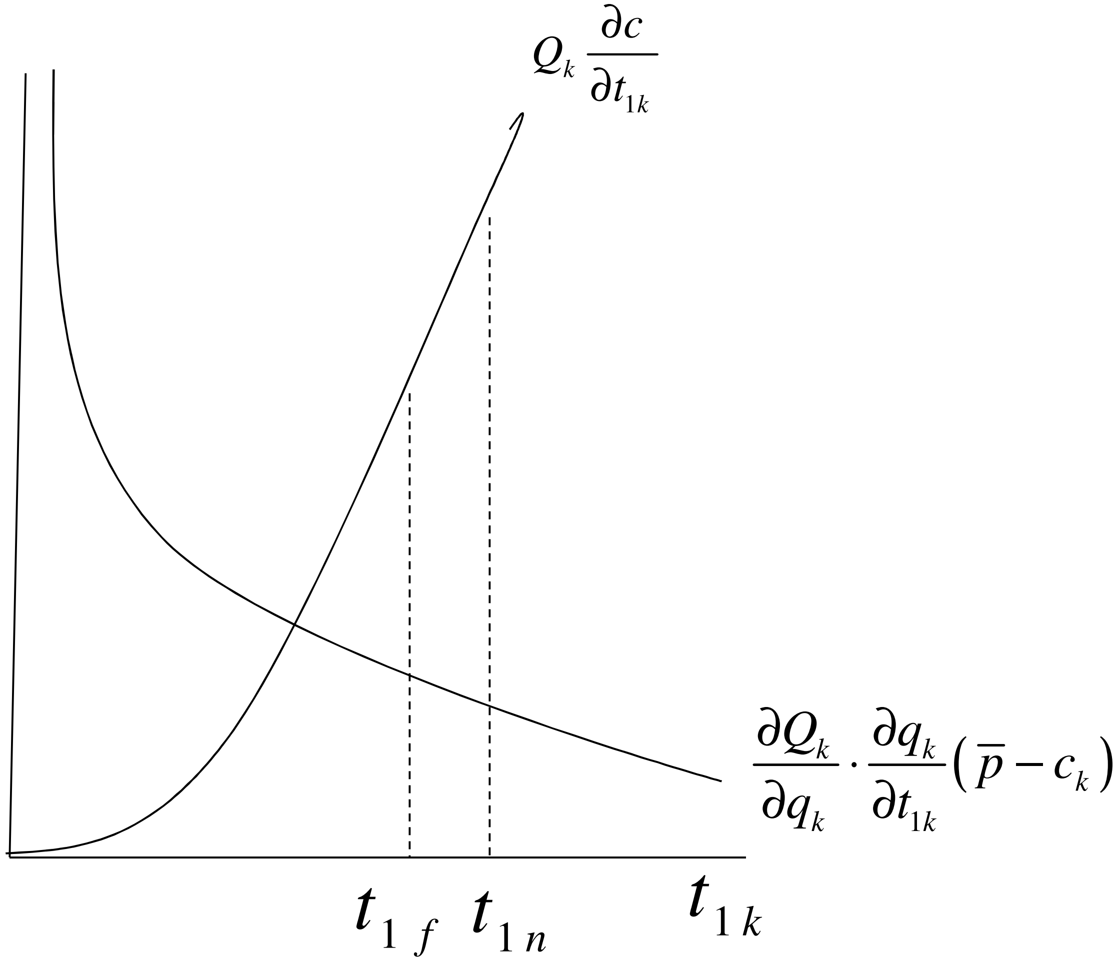

Figure 2
Proof that $t_{1n} > t_{1f}$