Hospital Competition and Quality with Regulated Prices

KURT R. BREKKE
LUIGI SICILIANI
ODD RUNE STRAUME

CESIFO WORKING PAPER NO. 2635
CATEGORY 11: INDUSTRIAL ORGANISATION
APRIL 2009

CESifo *Working Paper No. 2635*

Hospital Competition and Quality with Regulated Prices

Abstract

We analyse the effect of competition on quality in hospital markets with regulated prices, considering both the effect of (i) introducing competition (monopoly versus competition) and (ii) increasing competition through lower transportation costs (increased substitutability) or a higher number of hospitals. With semi-altruistic providers and a fairly general cost structure, we show that the relationship between competition and quality is generally ambiguous. In contrast to the received theoretical literature, this is consistent with, and potentially explains, the mixed empirical evidence.

JEL Code: H42, I11, I18, L13.

Keywords: hospitals, competition, quality.

Kurt R. Brekke
Department of Economics and Health Economics Bergen
Norwegian School of Economics and Business Administration
Helleveien 30
5045 Bergen
Norway
kurt.brekke@nhh.no

Luigi Siciliani
Department of Economics and Related Studies & Centre for Health Economics
University of York
Heslington, York YO10 5DD
United Kingdom
ls24@york.ac.uk

Odd Rune Straume
Department of Economics
University of Minho
Campus de Gualtar
4710-057 Braga
Portugal
o.r.straume@eeg.uminho.pt

1 Introduction

Quality is a major concern in health care. Recent and ongoing reforms in several countries to stimulate competition and patient choice among publicly funded hospitals have highlighted the importance of establishing more knowledge about the relationship between competition and quality.[1] While the present paper is a new attempt to address this general topic, we restrict our attention to the case of quality competition between health care providers facing *regulated prices*, which is relevant for most European health care systems as well as the U.S. Medicare and Medicaid programmes.

The introduction of market mechanisms in the health care sector – through a combination of prospective payment systems and free patient choice – aims at giving health care providers incentives to attract more patients (and thus payments) by offering a higher quality of care. Indeed, the existing theoretical literature on quality competition with regulated prices is practically unanimous in reporting a positive relationship between competition – measured either as a switch from monopoly to (imperfect) competition or as a marginal increase in the intensity of competition – and quality. In a general setting, this conclusion is reached in, e.g., Ma and Burgess (1993), Wolinsky (1997), Brekke, Nuscheler and Straume (2006) and Matsumura and Matsushima (2007), while, in a more specific health care setting, the same conclusion is reached in, e.g., Calem and Rizzo (1995), Gravelle (1999), Lyon (1999), Gravelle and Masiero (2000), Beitia (2003), Nuscheler (2003), Brekke, Nuscheler and Straume (2007) and Karlsson (2007).

However, the empirical evidence, though relatively scarce, seems to be considerably more ambiguous. For example, while Kessler and McClellan (2000) and Tay (2003) find a positive effect of competition on quality in the health care sector (with fixed prices), Gowrinsankaran and Town (2003) find a negative effect, Shen (2003) finds mixed effects, and Shortell and Hughes (1988) and Mukamel, Zwanziger and Tomaszewski (2001) find

[1] Examples include the UK, where hospitals are paid a tariff for every patients treated (Payment by Results) and patients have been given a free choice of hospital. Similar reforms have been introduced in Norway, Denmark, Italy and several other European countries.

no effects.[2,3]

In this paper we extend and generalise the received theoretical literature in several directions by simultaneously including (i) heterogeneous patients and elastic total demand for health care, (ii) semi-altruistic health care providers, and (iii) general cost functions that are non-separable in activity and quality. We analyse, first, the effect of a policy regime switch from monopoly to competition (i.e., introducing free patient choice). Second, we study the effect of increasing competition either through lower transportation costs (i.e., increasing the degree of substitutability among hospitals) or by increasing the number of hospitals. In our choice of theoretical framework – a Salop model with symmetrically distributed health care providers – we follow the existing theoretical literature, where quality competition is typically analysed within a spatial competition framework.

Our key contribution is to model health care providers as being semi-altruistic. While this is a quite common assumption in the general literature on health care supply, it has seldom been applied in a context of competition between health care providers.[4] Indeed, the present paper is – to the best of our knowledge – the first attempt to incorporate altruistic behaviour when studying the relationship between competition and quality.[5] Our analysis shows that this assumption potentially makes a huge difference. Whether we consider the *introduction* of competition or an increase in the *degree* of competition, we show that the relationship between competition and quality is generally ambiguous and depends crucially on hospital cost structure and the degree of altruism. More specifically,

[2] See Gaynor (2006) for a survey of theoretical and empirical literature on the relationship between hospital competition and quality.

[3] There are also several empirical studies analysing the relationship between competition and quality – finding mixed results – when prices are set by the hospitals. See, e.g., Dranove and Satterthwaite (1992), Dranove, Shanley and Simon (1992), Ho and Hamilton (2000), Sari (2002) and Propper, Burgess and Green (2004). The case of quality competition with *endogenous prices* is not addressed in the present paper. Besides, it is well known that the relationship between competition and quality is theoretically more ambiguous in this particular case.

[4] Hirth (1999) and Harrison and Lybecker (2005) introduce non-profit objectives in a setting of competition between health care providers. However, since competition is analysed in a setting of flexible prices and the relationship between competition and quality is not an issue in either paper, these studies are quite different from ours. A more general analysis of competition in non-profit versus for-profit industries is found in Lakdawalla and Philipson (2006).

[5] Ellis (1998) also models competition between semi-altruistic health care providers. However, he does not address the relationship between competition and quality but focuses instead on the effect of different reimbursement schemes on providers' incentives for over- versus under-provision of services to different types of patients.

a sufficient degree of altruism may, for certain hospital cost structures, lead to a *negative* relationship between competition and equilibrium quality.

Comparing monopoly and competition, a negative relationship between competition and quality is more likely to occur (for a given degree of altruism) if the number of patients who make choices between different hospitals – what we dub the "competitive demand segment" – is sufficiently large relative to the number of patients who do not make such choices. The key mechanism that contributes to this reversal result is that semi-altruistic behaviour may lead to negative *marginal* profits in equilibrium.[6] Due to mechanisms that will be described in detail in subsequent sections, this implies that competition has an *a priori* ambiguous effect on hospital quality incentives.

We also show that *intensified competition* measured by reduced transportation costs may lead to lower equilibrium quality even if health care providers are pure profit maximisers, implying positive marginal profits in equilibrium. Though apparently counterintuitive and in contrast with previous literature – the result is due to strict convexity and non-separability in the cost function – we can show that this particular result depends on the presence of a non-competitive demand segment and is essentially a demand effect, rather than a pure competition effect.

Finally, we show that quality incentives are generally ambiguous also with respect to the perhaps most usual competition measure, namely the number of hospitals in the market. This result crucially hinges on the degree of altruism. In the absence of altruism, a higher hospital density will always lead to higher quality. However, if the degree of altruism is sufficiently high relative to the degree of cost convexity (and/or cost substitutability between quantity and quality), the effect of more hospitals is in fact reversed. The intuition is related to the fact that, when the number of hospitals increases, each hospital faces a lower demand, which results in fewer treated patients and lower marginal patient benefit of quality investments at hospital level.

The main structure of our model – which is presented in the next section – is based

[6] We ensure of course that the (semi-altruistic) hospitals earn non-negative profits in equilibrium, although their marginal profits might be negative. With strictly convex production costs, negative marginal profits do not imply that overall profits are negative in equilibrium.

on Brekke, Siciliani and Straume (2008). In that paper, we analyse the effect of hospital competition on waiting times, rather than quality. While there are clear parallels between waiting times and more general quality of care – as the former can be interpreted as a negative form of hospital quality – there are also important differences. While increasing quality is costly for the provider, reducing waiting times is not. More precisely, while increasing quality has a direct and an indirect cost for the provider, reducing waiting times only has an indirect cost, through a higher demand. Thus, the results in Brekke, Siciliani and Straume (2008) do not automatically carry over to the case of quality competition. For example, while a higher hospital density unambiguously reduces waiting times, the effect on hospital quality is ambiguous. More generally, while the *degree* of altruism does not generally affect the relationship between competition and waiting times, it plays a crucial role in explaining the relationship between competition and quality, as we will show below.

The rest of the paper is organised as follows. In Section 2, we present the model. In Section 3, we derive equilibrium quality under, respectively, local monopoly and competition, and analyse which regime that provides more incentives for quality provision. In Section 4, we consider a regime of free patient choice (competition) and investigate the impact of intensified competition, both in terms of lower transportation costs and a higher number of hospitals. Section 5 concludes the paper.

2 Model

Consider a market for elective hospital treatment where n hospitals are equidistantly located on a circle with circumference equal to 1. There are two patient types – $L(ow)$ and $H(igh)$ – differing with respect to the gross valuation of treatment. Both types are uniformly distributed on the circle with density normalised to 1. A patient demands either one treatment from the most preferred hospital, or no treatment at all. The utility of a patient of type $s \in \{L, H\}$, who is located at x and being treated at hospital i, located at

z_i, is given by

$$U^s(x, z_i) = \begin{cases} V - t|x - z_i| + kq_i & if \quad s = H \\ v - t|x - z_i| + kq_i & if \quad s = L \end{cases}, \tag{1}$$

where $q_i \geq \underline{q}$ is the quality at hospital i, k is a parameter measuring the (marginal) utility of quality, t is a transportation cost parameter, and $V - v > 0$ measures the difference in the gross valuation of treatment between the two types.[7,8] The lower bound $\underline{q}$ on hospital quality represents the minimum treatment quality hospitals are allowed to offer, implying that $q < \underline{q}$ can be interpreted as malpractice. For simplicity, we set $\underline{q} = 0$. Moreover, we normalise the marginal utility of quality to one, i.e., $k = 1$, without loss of generality. This implies that t can be interpreted as the marginal disutility of travelling *relative* to quality. Thus, a low (high) t means that quality is of relatively more (less) importance to the patient than travelling distance.[9]

The H-segment constitutes a share λ of the total number of patients, which is normalised to 1. We focus on equilibria where the H-segment is fully covered, while the L-segment is only partly covered, i.e., some L-patients will not seek treatment in equilibrium.[10] The former assumption means that there is competition (or scope for competition) in the market, while the latter assumption implies that total demand for hospital treatment is elastic with respect to quality.[11] We will intermittently refer to the L- and H-segments

[7] Differences in gross valuations across patients can be due to differences in age, gender, illness severity, or simply opportunity costs. For example, old patients with a non-severe condition might have a low valuation of medical treatment.

[8] Transportation costs can be given a broad interpretation to include all costs (disutility) associated with being far from "home" to receive treatment. There is also strong empirical evidence showing that distance is a major predictor of patients' choice of hospital, see, e.g., Kessler and McClellan (2000) and Tay (2003).

[9] An alternative non-physical interpretation of the horizontal dimension is a disease space, where the location of a patient is associated with the disease she suffers from, and the hospitals are differentiated with respect to the disease they are best able to cure, reflecting hospital specialisation or "service mix" (see, e.g., Calem and Rizzo, 1995, and Brekke, Nuscheler and Straume, 2007).

[10] This essentially requires that the difference in gross valuation of treatment is sufficiently large between the two patient types.

[11] Notice that, by focusing on the equilibrium with a fully covered H-segment and a partly covered L-segment, we are able to cover the other possibility – full market coverage in both demand segments – as a special case. By setting $\lambda = 1$, the model is reduced to a standard model with only one demand segment (where total demand is inelastic), but this is qualitatively equivalent to the case of two demand segments where both are fully covered in equilibrium.

as the monopoly and competitive demand segments, respectively.

Hospitals are prospectively financed by a third-party payer offering a per-treatment price p and potentially a lump-sum transfer T. The objective function of hospital i is assumed to be given by

$$\pi_i\left(q_i, \mathbf{q}_{-i}\right) = T + pX_i\left(q_i, \mathbf{q}_{-i}\right) + \alpha B_i\left(q_i, \mathbf{q}_{-i}\right) - C\left(X_i\left(q_i, \mathbf{q}_{-i}\right), q_i\right), \tag{2}$$

where $X_i\left(q_i, \mathbf{q}_{-i}\right)$ is demand for treatment at hospital i (derived from individual utility maximisation) and $\mathbf{q}_{-i}$ represents the vector of qualities at neighbouring hospitals. The cost of supplying hospital treatments is given by the cost function $C\left(X_i, q_i\right)$, with $C_X > 0$, $C_q > 0$, $C_{XX} \geq 0$ and $C_{qq} > 0$.[12] We also assume $C_{Xq} \geq 0$, i.e., quality and quantity are (weakly) substitutes: an increase in quality is more costly when more patients are treated. The function $B_i\left(\cdot\right)$ represents the total benefit of the patients receiving treatment at hospital i, while the parameter $\alpha \in [0, 1]$ captures the degree of altruism of the provider.[13] We assume that hospitals cannot turn down patients seeking treatment, implying that we do not allow for explicit rationing.

The hospitals simultaneously and independently choose qualities, in order to maximise their objective functions. Maximising (2) with respect to q_i and applying symmetry, the equilibrium quality, q^*, is given by[14,15]

$$\frac{\partial X_i\left(q^*\right)}{\partial q_i}\left[p - C_X\left(X_i\left(q^*\right), q^*\right)\right] + \alpha\frac{\partial B_i\left(q^*\right)}{\partial q_i} = C_q\left(X_i\left(q^*\right), q^*\right), \quad i = 1, 2, \tag{3}$$

where $\partial X_i/\partial q_i > 0$ and $\partial B_i/\partial q_i > 0$.

[12] A convex variable cost function is supported by evidence suggesting that economies of scale are quite rapidly exhausted in the hospital sector (see, e.g., Ferguson et al., 1999, and Folland et al., 2004, for literature surveys).

[13] This formulation is consistent with, e.g., Ellis and McGuire (1986), Chalkley and Malcolmson (1998) and Jack (2005). Notice also that it is general, since the special case of a profit-maximising hospital can be recovered by setting $\alpha = 0$.

[14] This equilibrium is characterised by a fully covered H-segment and a partially covered L-segment if $\frac{t}{2n} \in (v + q^*, V + q^*)$.

[15] Notice that the interior equilibrium implicitly relies on the assumption that a limited liability constraint is not binding, i.e.,

$$T + pX\left(q^*\right) - C\left(X\left(q^*\right), q^*\right) \geq 0.$$

The marginal benefit from quality is given by the higher revenues and the non-monetary benefit arising from altruism. The marginal cost of quality includes the direct marginal cost of quality investments and the increased marginal cost of treatment that arises from the demand increase. The combination of altruistic preferences and increasing marginal treatment costs makes the sign of marginal profits, $p - C_X$, ambiguous in equilibrium.[16] More specifically, marginal profits are negative in equilibrium if the marginal altruistic gain of a quality increase is larger than the direct marginal cost: $\alpha\left(\partial B_i/\partial q_i\right) > C_q$.[17]

3 Competition or monopoly?

Consider two distinctly different policy regimes: 1) a benchmark case of *no competition*, where patients are assigned to hospitals purely according to geographical distance and hospitals are in effect local monopolies; 2) *competition*, where patients are free to choose among hospitals when demanding treatment.[18] The choice of policy regime affects the demand responsiveness to quality, $\partial X_i/\partial q_i$, which, in turn, affects the marginal altruistic utility gain, $\partial B_i/\partial q_i$. From (3) we see that these are the two channels through which competition might affect quality.

3.1 Monopoly

Without free patient choice, hospital i's demand from the H-segment is exogenously given by $X_i^H = 1/n$. In the L-segment, the patient who is indifferent between treatment at hospital i and no treatment is located at x_i^L, given by $v - tx_i^L + q_i = 0$, or, more explicitly, $x_i^L = \left(v + q_i\right)/t$. Total demand for hospital i from the L-segment is given by $X_i^L = 2x_i^L$.

[16] Notice that, by *marginal profits* we refer here (and throughout the paper) to the change in profits due to a marginal increase in production, not quality.

[17] Notice that, with strictly convex production costs, negative marginal profits do not imply that profits are negative in equilibrium.

[18] General Practioners (GPs) are often involved in the choice of hospital, especially in gatekeeping systems. A GP is an expert and might recommend a hospital to the patient based on quality (and distance); see Brekke, Nuscheler and Straume (2007). It is not crucial for the analysis whether it is the GP or the patient that makes the choice of hospital.

Total demand for hospital i (from both patient segments) is thus given by

$$X_i(q_i) = \frac{\lambda}{n} + (1-\lambda)\frac{2(v+q_i)}{t}, \tag{4}$$

while total utility for the patients treated at hospital i is given by

$$B_i(q_i) = \lambda 2\int_0^{\frac{1}{2n}} (V + q_i - tx)\,dx + (1-\lambda)\,2\int_0^{\frac{v+q_i}{t}} (v + q_i - tx)\,dx, \tag{5}$$

yielding

$$\frac{\partial X_i(q_i)}{\partial q_i} = \frac{2(1-\lambda)}{t} > 0 \tag{6}$$

and

$$\frac{\partial B_i(q_i)}{\partial q_i} = X_i(q_i) > 0. \tag{7}$$

Notice that lower transportation costs makes it less costly for patients to demand treatment; this increases demand responsiveness from L-type patients to hospital quality changes. Regarding (7), notice that a quality increase at hospital i has, in general, two effects on total utility for patients treated at the hospital: first, it increases utility for all patients that are already treated at the hospital; second, it increases demand for hospital i treatment. Since, in the absence of competition, the demand increase only comes from the L-segment, the utility contribution is zero at the margin. Thus, there is a positive utility contribution only from inframarginal patients.

Equilibrium quality under monopoly, $q^* = q^m$, is then found by substituting (4)-(7) into (3).[19]

3.2 Competition

With free patient choice, the hospitals' quality choices affect demand also in the H-segment. Since the distance between hospitals is equal to $1/n$, the H-patient who is indifferent between seeking treatment at hospital i and hospital j is located at x_i^H, given

[19] The second-order condition is given by $\partial^2\pi_i/\partial q_i^2 = -\left(C_{XX}\frac{2(1-\lambda)}{t} + 2C_{Xq} - \alpha\right)\frac{2(1-\lambda)}{t} - C_{qq} < 0$, which holds if the cost function is sufficiently convex in quality.

by $V - tx_i^H + q_i = V - t\left(1/n - x_i^H\right) + q_j$, or, more explicitly, $x_i^H = \left(q_i - q_j + \frac{t}{n}\right)/2t$. Assuming that quality is the same at both neighbouring hospitals[20], and given by q_j, total demand for hospital i from the H-segment is given by $X_i^H = 2x_i^H$. Demand from the L-segment is the same as before. Total demand facing hospital i from both segments is thus given by

$$X_i\left(q_i, q_j\right) = \lambda X_i^H + \left(1-\lambda\right) X_i^L = \frac{2\left(1-\lambda\right)v + q_i\left(2-\lambda\right) - \lambda q_j}{t} + \frac{\lambda}{n}, \tag{8}$$

while the surplus to patients treated at hospital i is given by

$$B_i\left(q_i, q_j\right) = 2\lambda \int_0^{\frac{1}{2t}\left(q_i - q_j + \frac{t}{n}\right)} \left(V + q_i - tx\right) dx + 2\left(1-\lambda\right) \int_0^{\frac{v+q_i}{t}} \left(v + q_i - tx\right) dx, \tag{9}$$

yielding

$$\frac{\partial X_i\left(q_i, q_j\right)}{\partial q_i} = \frac{2-\lambda}{t} \tag{10}$$

and

$$\frac{\partial B_i\left(q_i, q_j\right)}{\partial q_i} = X_i\left(q_i, q_j\right) + \frac{\lambda}{t}\left(V + \frac{q_i + q_j}{2} - \frac{t}{2n}\right). \tag{11}$$

Comparing (6) and (10), we see that the demand responsiveness to quality changes is higher under competition than under monopoly. The reason is simply that, under competition, there is a demand response also in the H-segment: an increase in the quality offered by hospital i will not only induce more L-types to seek treatment, it will also attract H-types who would otherwise have sought treatment at a neighbouring hospital.

Comparing (7) and (11), we also see that the increase in total patient utility from a marginal increase in quality at hospital i is higher under competition than under monopoly. The reason is that, with competition, a quality increase leads to an inflow of patients (from the competitive segment) with a strictly positive net utility of hospital treatment. In other words, there is a utility contribution from both marginal and inframarginal patients. Intu-

[20] Since the model is symmetric, notice that, when solving for the Nash equilibrium, we can define X_i and B_i for $q_{i-1} = q_{i+1} = q_j$, maximise π_i with respect to q_i and then set $q_i = q_j$ to derive the quality level in the symmetric equilibrium.

itively, the difference between (7) and (11) depends on the relative size of the competitive segment, given by λ.

Equilibrium quality under competition, $q^* = q^c$, is found by substituting (8)-(11) into (3) and setting $q_i = q_j = q^c$.[21]

3.3 Competition versus monopoly

A comparison of the two policy regimes with respect to equilibrium quality yields the following result:

Proposition 1 *Competition between hospitals lead to higher (lower) quality in equilibrium if the competitive segment (λ) is below (above) a threshold level $\widehat{\lambda}$, given by*

$$\widehat{\lambda} := 1 + \frac{t}{2(V-v)}\left(\frac{C_q\left(X_i\left(q^m\right), q^m\right)}{\alpha} - \frac{1}{n}\right). \tag{12}$$

Proof. Combining the two equilibrium conditions (under monopoly and competition, respectively) yields, after some manipulations,

$$\begin{aligned} & \frac{2}{\alpha}\left[C_X\left(X_i\left(q^m\right), q^m\right) - C_X\left(X_i\left(q^c\right), q^c\right)\right] + 2\left(q^c - q^m\right) \\ & + \frac{2t}{\alpha(2-\lambda)}\left[C_q\left(X_i\left(q^m\right), q^m\right) - C_q\left(X_i\left(q^c\right), q^c\right)\right] \\ = & -\frac{\lambda}{(1-\lambda)(2-\lambda)}\left[\frac{2(V-v)n(1-\lambda) - t}{n} + \frac{tC_q\left(X_i\left(q^m\right), q^m\right)}{\alpha}\right]. \end{aligned}$$

We need first to confirm monotonicity of the left-hand side (LHS) of the above equation in q^m and q^c. Taking the first-order derivative yields

$$\frac{\partial(LHS)}{\partial q^c} = -\frac{2}{\alpha}\left(C_{XX}\frac{2-\lambda}{t} + C_{Xq}\right) + 2 - \frac{2t}{\alpha(2-\lambda)}\left(C_{qq} + C_{Xq}\frac{2-\lambda}{t}\right)$$

[21] The second-order condition is $\partial^2\pi_i/\partial q_i^2 = -\left[\left(C_{XX}\frac{2-\lambda}{t} + 2C_{Xq} - \alpha\right)\frac{2-\lambda}{t} - \alpha\frac{\lambda}{2t} + C_{qq}\right] < 0$, which is always satisfied if the cost function is sufficiently convex in quality.

and

$$\frac{\partial(LHS)}{\partial q^m} = \frac{2}{\alpha}\left(C_{XX}\frac{2\left(1-\lambda\right)}{t} + C_{Xq}\right) - 2 + \frac{2t}{\alpha\left(2-\lambda\right)}\left(C_{qq} + C_{Xq}\frac{2(1-\lambda)}{t}\right).$$

By applying the second-order conditions we confirm that $\partial(LHS)/\partial q^c < 0$ and $\partial(LHS)/\partial q^m > 0$. Since $LHS = 0$ if $q^c = q^m$, it follows that $q^c > (<) q^m$ if the right-hand side of the equation is negative (positive), which is the case if

$$\lambda < (>)\, 1 + \frac{t}{2\left(V-v\right)}\left(\frac{C_q\left(X_i\left(q^m\right), q^m\right)}{\alpha} - \frac{1}{n}\right).$$

■

Consider first the benchmark case of pure profit-maximising behaviour. From (12) we see that $\alpha \to 0$ implies $\widehat{\lambda} \to \infty$. Thus, without altruism, competition leads to higher equilibrium quality for all $\lambda \in (0,1)$, as expected.

In the presence of altruism, however, the effect of competition on quality is a result of two counteracting forces. On the one hand, competition increases the marginal altruistic gain of quality (cf. (7) and (11)), since hospitals can attract high-benefit patients by increasing quality. *Ceteris paribus*, this leads to higher hospital quality in equilibrium. On the other hand, competition increases the demand responsiveness to quality (cf. (6) and (10)). Whether or not the latter effect increases quality incentives depends on the sign of the marginal profits, $p - C_X$, in the monopoly equilibrium. If marginal profits are positive, hospitals will compete more fiercely to attract patients also for purely profit-oriented reasons, and competition will unambiguously increase quality.

However, if the marginal profits are negative – which requires a certain degree of altruism – a more quality-responsive demand implies, *ceteris paribus*, that hospitals have less incentives to invest in quality, since the marginal patient is financially unprofitable to treat. If this is the case, then the introduction of competition has an ambiguous effect on equilibrium quality, and competition will lead to lower quality if the (financial) incentive to avoid unprofitable patients is stronger than the (altruistic) incentive to attract

high-benefit patients. In general, the former incentive tends to dominate – establishing a negative relationship between competition and quality – if marginal profits are sufficiently negative in the monopoly equilibrium. This tends to be the case if the degree altruism is high and hospital density is low, relative to the direct marginal cost of quality.[22]

As the above analysis shows, $\alpha > 0$ is a necessary but not sufficient condition for a negative relationship between competition and quality. However, it should be stressed that our way of modeling of altruism is a somewhat extreme case among the plausible alternatives. We have assumed that decision makers have semi-altruistic preferences only towards patients treated at their own hospital. The other extreme case would be to assume that decision makers at each hospital care equally much about all patients in the market, regardless of where they are treated. In this case, the marginal altruistic gain of quality would be the same under monopoly and competition.[23] This would eliminate the incentive to attract high-benefit patients for altruistic reasons, implying that, if marginal profits are negative in the monopoly equilibrium, competition would always reduce equilibrium quality. Thus, the condition given in Proposition 1 should be seen as a lower bound on the likelihood that semi-altruistic behaviour leads to a negative relationship between competition and quality.

4 Intensity of competition

In this section we consider a competition regime with free patient choice and analyse whether or not intensified competition will lead to higher quality. We measure intensified competition in two ways: first, we study the impact of lower transportation costs (i.e., increased substitutability); second, we analyse the impact of more hospitals in the market.

[22] Notice that $\widehat{\lambda} > (<) 1$ if $C_q > (<) \frac{\alpha}{n}$, i.e., if the direct marginal cost of quality is larger (smaller) than the marginal altruistic gain in the monopoly equilibrium, implying positive (negative) marginal profits.

[23] In both cases, $\partial B/\partial q_i = X_i$.

4.1 Transportation costs (substitutability)

Consider the effect of *increasing the degree of competition* in the market through lower transportation costs, i.e., increasing the substitutability among the hospitals in the market, which is a standard competition measure in the previously cited literature.[24]

In our framework, lower transportation costs have two different effects: it makes demand more responsive to quality changes and it increases total demand from the L-segment. Totally differentiating the first-order conditions in the competition regime, and applying Cramer's rule, we obtain a generally indeterminate total effect:

$$\frac{\partial q^c}{\partial t} = \frac{-\frac{\partial X}{\partial t}\left[\frac{2-\lambda}{t}C_{XX} + C_{Xq}\right] - \left[\frac{(2-\lambda)}{t^2}(p - C_X) + \frac{\alpha\lambda}{t^2}(V + q^c) - \alpha\frac{\partial X}{\partial t}\right]}{\left(\frac{2-\lambda}{t}C_{XX} + C_{Xq} - \alpha\right)\frac{2(1-\lambda)}{t} - \alpha\frac{\lambda}{t} + C_{qq} + C_{Xq}\frac{2-\lambda}{t}} \gtrless 0, \qquad (13)$$

where $\partial X/\partial t = -2(1-\lambda)(q^c + v)/t^2$. The second-order condition ensures that the denominator is positive, so the sign of the expression is determined by the sign of the numerator.

Consider first, as a benchmark, the standard case of pure profit-maximising behaviour ($\alpha = 0$) and inelastic total demand ($\lambda = 1$). Since $\lambda = 1$ eliminates the demand effect ($\partial X/\partial t = 0$), the numerator reduces to $-(2-\lambda)(p - C_X)/t^2$. Since $\alpha = 0$ ensures that $p > C_X$ in equilibrium, this expression in unambiguously negative. Thus, we recover the standard result from the literature that lower transportation costs increase quality.

In the more general case of $\alpha \in (0,1)$ and $\lambda \in (0,1)$, results are more ambiguous. The first term in the numerator is always positive (since $\partial X/\partial t < 0$). Using the first-order condition, we can show that the second term is also positive if $\alpha\lambda/2n > C_q(\cdot)$, i.e., if altruism is sufficiently high relative to the direct marginal cost of quality investments.[25] In this case, $\partial q^c/\partial t > 0$, implying that increased competition unambiguously reduces

[24] Notice that t can, to some extent, be thought of as a policy variable. For example, in Norway patients' travelling costs are partially reimbursed by the public payer. In many countries, there is also an increased (policy-induced) availability of performance indicators on quality which facilitates comparison across health care providers. Although this is mainly related to informational issues, which are not explicitly modelled in the present paper, Brekke, Nuscheler and Straume (2006) have shown, in a similar model, that increased patient information is qualitatively equivalent to reduced transportation costs.

[25] Notice that this condition implies negative marginal profits, since $\frac{2-\lambda}{t}(p - C_X) = \left(C_q - \alpha\frac{\lambda}{2n}\right) - \left(\frac{\lambda}{t}(V + q^c) + \frac{2(1-\lambda)}{t}(v + q^c)\right)$ in equilibrium.

quality. Notice that this result – that lower transportation costs reduce quality if the degree of altruism is sufficiently high – holds qualitatively also for the special case of $\lambda = 1$, and the intuition for the result closely mirrors the intuition given for Proposition 1.

On the other hand, if marginal profits are positive and sufficiently large, we obtain the standard result from the literature, that more competition increases quality. Notice, however, that positive marginal profits is *not* a sufficient condition for increased competition to increase quality. Furthermore, even without altruism, it is not necessarily the case that lower transportation costs increase quality. By setting $\alpha = 0$ in (13) we still obtain $\partial q^*/\partial t \gtreqless 0$, in contrast to the received literature. This is due to our assumptions of increasing marginal activity costs and non-separability in the cost function. It is important to stress, though, that this is a demand effect rather than a competition effect. If we eliminate the demand effect by setting $\lambda = 1$, the ambiguity of the relationship between t and q^* only survives for $\alpha > 0$.

We summarise the above analysis and discussion as follows:

Proposition 2 *(i) Lower transportation costs have in general an indeterminate effect on quality, even if marginal profits are positive in equilibrium, and even if the degree of altruism is zero;*

(ii) Lower transportation costs always reduce quality if the degree of altruism is large relative to the direct marginal cost of quality;

(iii) If marginal profits are positive in equilibrium, the marginal cost of treatment is constant and the cost function is separable in quality and activity, then lower transportation costs always increase quality.

4.2 The number of hospitals (density)

The perhaps most direct and obvious competition variable is the number of hospitals. In our framework there is local competition. This means that a higher number of hospitals will increase the density of hospitals in the market. The effect of more hospitals might seem

obvious in the sense that we would expect hospitals to compete more fiercely for patients. Thus, we would expect that quality increases as more hospitals enter the market. As we will see, the relationship between hospital density and quality is not so obvious.

The impact of a higher number of hospitals on equilibrium quality is obtained by totally differentiating the first-order conditions in the competition regime, and applying the Cramer's rule, yielding

$$\frac{\partial q_i^c}{\partial n} = \frac{-\frac{\partial X_i}{\partial n}\left[\left(\frac{2-\lambda}{t}\right)C_{XX} + C_{qX} - \frac{\alpha}{2}\right]}{\left(\frac{2-\lambda}{t}C_{XX} + C_{Xq} - \alpha\right)\frac{2(1-\lambda)}{t} - \alpha\frac{\lambda}{t} + C_{qq} + C_{Xq}\frac{2-\lambda}{t}}, \tag{14}$$

where $\partial X_i/\partial n = -\lambda/n^2$. The second-order condition ensures that the denominator is positive, so the sign of the expression is determined by the sign of the numerator.

Proposition 3 *A higher number of hospitals leads to lower (higher) quality in equilibrium if the degree of altruism is above (below) a threshold level* $\widehat{\alpha}$*, given by*

$$\widehat{\alpha} := 2\left[\left(\frac{2-\lambda}{t}\right)C_{XX} + C_{qX}\right]. \tag{15}$$

In order to explain the intuition behind this result, let us once more start by considering the benchmark case of pure profit-maximising behaviour. If $\alpha = 0$, the numerator in (14) is unambiguously positive, implying that more hospitals always lead to higher quality, as long as C_{XX} and/or C_{Xq} are strictly positive. Higher hospital density means that each hospital faces lower demand and thus performs fewer treatments. If hospital costs are strictly convex in output, lower demand increases marginal profits $(p - C_X)$, making it more profitable for each hospital to attract extra patients by increasing quality. Cost substitutability between quantity and quality ($C_{Xq} > 0$) amplifies this effect.

However, with semi-altruistic providers, a counteracting effect is introduced. When fewer patients are treated at each hospital, the marginal patient benefit of higher quality is correspondingly reduced (see (11)). All else equal, this gives each hospital weaker incentives to increase quality for altruistic reasons. If the degree of altruism is sufficiently high relative to the degree of production cost convexity and/or cost substitutability between

quantity and quality, the counteracting effect dominates and a higher number of hospitals results in lower quality. For example, in the case of constant marginal cost of production and cost independence between quantity and quality, which are standard assumptions in the cited literature, we see from (15) that the threshold level of altruism reduces to $\widehat{\alpha} = 0$, implying that there is always a negative relationship between the number of hospitals and equilibrium quality with semi-altruistic providers.

Finally, observe that, although the effects of higher hospital density are related to changes in individual hospital demand, the presence of a competitive segment is crucial for the results. If there is no competitive segment ($\lambda = 0$), then a higher number of hospitals has no effect on quality incentives.

5 Concluding remarks

With semi-altruistic health care providers and a general convex cost structure, a positive relationship between hospital competition and quality is no longer guaranteed. Therefore, our model – which extends and generalises the existing theoretical literature – is useful to clarify under which conditions we might expect competition to increase (resp., decrease) quality.

Our key contribution is to carry the assumption of semi-altruistic health care providers over to a context of quality competition. There are several features that are thought to distinguish the market for health care from markets for other consumption goods. One important distinguishing feature is semi-altruistic provider preferences, an assumption that is reasonably common in the literature on health care supply but rarely used in other contexts. What we have shown in this paper is that this particular assumption can lead to counterintuitive and perhaps unexpected effects of competition. Besides offering a possible explanation for the mixed empirical evidence on the effect of competition on quality, there is also a potential lesson to be learned for policy makers as well as analysts of health care markets: if we believe that there are some important features that distinguish health care markets from other markets, such as altruistic provider preferences, we should also be

careful about carrying standard intuition about product market competition – that more competition leads to higher quality – over to markets for health care.

By way of conclusion, we would also like to emphasise that even if policy measures to increase competition among health care providers do not lead to the expected result – higher quality of health care – it does not automatically follow that such policy measures should not be undertaken. However, an analysis of the desirability of such policies would require a full-fledged welfare analysis, which is beyond the scope of this paper.

References

[1] Beitia, A., 2003. Hospital quality choice and market structure in a regulated duopoly. Journal of Health Economics, 22, 1011–1036.

[2] Brekke, K.R., Nuscheler, R., Straume, O.R., 2006. Quality and location choices under price regulation. Journal of Economics & Management Strategy, 15, 207–227.

[3] Brekke, K.R., Nuscheler, R., Straume, O.R., 2007. Gatekeeping in health care. Journal of Health Economics, 26, 149–170.

[4] Brekke, K.R., Siciliani, L., Straume, O.R., 2008. Competition and waiting times in hospital markets. Journal of Public Economics, 92, 1607–1628.

[5] Calem, P.S., Rizzo, J.A., 1995. Competition and specialization in the hospital industry: an application of Hotelling's location model. Southern Economic Journal, 61, 1182–1198.

[6] Chalkley, M., Malcomson, J.M., 1998. Contracting for Health Services when patient demand does not reflect quality. Journal of Health Economics, 17, 1–19.

[7] Dranove, D. D., Satterthwaite, M. A., 1992. Monopolistic competition when price and quality are imperfectly observable. Rand Journal of Economics, 23, 518–534.

[8] Dranove, D. D., Shanley, M., Simon, C., 1992. Is hospital competition wasteful? Rand Journal of Economics, 23, 247–262.

[9] Ellis, R.P., 1998. Creaming, skimping and dumping: provider competition on the intensive and extensive margins. Journal of Health Economics, 17, 537–555.

[10] Ellis, R.P., McGuire, T., 1986. Provider behavior under prospective reimbursement: Cost sharing and supply. Journal of Health Economics, 5, 129–151.

[11] Ferguson, B., Sheldon, T., Posnett, J. (eds.), 1999. Concentration and choice in health care. London: Royal Society of Medicine.

[12] Folland, S., Goodman, A.C., Stano, M., 2004. The economics of health and health care. Upper Saddle River, NJ: Prentice Hall.

[13] Gaynor, M., 2006. What do we know about competition and quality in health care markets? Foundations and Trends in Microeconomics, Vol. 2, Issue 6.

[14] Gowrisankaran, G., Town, R., 2003. Competition, payers, and hospital quality. Health Services Research, 38, 1403–1422.

[15] Gravelle, H., 1999. Capitation contracts: access and quality. Journal of Health Economics, 18, 3, 315–340.

[16] Gravelle, H., Masiero, G., 2000. Quality incentives in a regulated market with imperfect competition and switching costs: capitation in general practice. Journal of Health Economics, 19, 1067–1088.

[17] Harrison, T.D., Lybecker, K.M., 2005. The effect of the nonprofit motive on hospital competitive behavior. Contributions to Economic Analysis & Policy: Vol. 4: Iss. 1, Article 3.

[18] Hirth, R.A., 1999. Consumer information and competition between nonprofit and for-profit nursing homes. Journal of Health Economics, 18, 219–240.

[19] Ho, V., Hamilton, B. H., 2000. Hospital mergers and acquisitions: does market consolidation harm patients? Journal of Health Economics, 19, 767–791.

[20] Jack, W., 2005. Purchasing health care services from providers with unknown altruism. Journal of Health Economics, 24, 73–93.

[21] Karlsson, M., 2007. Quality incentives for GPs in a regulated market. Journal of Health Economics, 26, 699–720.

[22] Kessler, D., McClellan, M., 2000. Is hospital competition socially wasteful? Quarterly Journal of Economics, 115, 577–615.

[23] Lakdawalla, D., Philipson, T., 2006. The nonprofit sector and industry performance. Journal of Public Economics, 90, 1681–1698.

[24] Lyon, T. P., 1999. Quality competition, insurance, and consumer choice in health care markets. Journal of Economics & Management Strategy, 8, 545–580.

[25] Ma, C.A., Burgess, J.F., 1993. Quality competition, welfare, and regulation. Journal of Economics, 58, 153–173.

[26] Matsumura, T., Matsushima, N., 2007. Congestion-reducing investments and economic welfare in a Hotelling model. Economics Letters, 96, 161–167.

[27] Mukamel, D., Zwanziger, J., Tomaszewski, K.J., 2001. HMO penetration, competition and risk-adjusted hospital mortality. Health Services Research, 36, 1019–1035.

[28] Nuscheler, R., 2003. Physician reimbursement, time-consistency and the quality of care. Journal of Institutional and Theoretical Economics, 159, 302–322.

[29] Propper, C., Burgess, S., Green, K., 2004. Does competition between hospitals improve the quality of care? Hospital death rates and the NHS internal market. Journal of Public Economics, 88, 1247–1272.

[30] Sari, N., 2002. Do competition and managed care improve quality? Health Economics, 11, 571–584.

[31] Shen, Y.-S., 2003. The effect of financial pressure on the quality of care in hospitals. Journal of Health Economics, 22, 243–269.

[32] Shortell, S. M., Hughes, E. F., 1988. The effects of regulation, competition, and ownership on mortality rates among hospital inpatients. New England Journal of Medicine, 318, 1100–1107.

[33] Tay, A., 2003. Assessing competition in hospital care markets: the importance of accounting for quality differentiation. RAND Journal of Economics, 34, 786–814.

[34] Wolinsky, A., 1997. Regulation of duopoly: Managed competition vs regulated monopolies. Journal of Economics & Management Strategy, 6, 821–847.

CESifo Working Paper Series

for full list see www.cesifo-group.org/wp
(address: Poschingerstr. 5, 81679 Munich, Germany, office@cesifo.de)

2573 Jo Thori Lind, Karl Ove Moene and Fredrik Willumsen, Opium for the Masses? Conflict-Induced Narcotics Production in Afghanistan, March 2009

2574 Silvia Marchesi, Laura Sabani and Axel Dreher, Agency and Communication in IMF Conditional Lending: Theory and Empirical Evidence, March 2009

2575 Carlo Altavilla and Matteo Ciccarelli, The Effects of Monetary Policy on Unemployment Dynamics under Model Uncertainty - Evidence from the US and the Euro Area, March 2009

2576 Falko Fecht, Kjell G. Nyborg and Jörg Rocholl, The Price of Liquidity: Bank Characteristics and Market Conditions, March 2009

2577 Giorgio Bellettini and Filippo Taddei, Real Estate Prices and the Importance of Bequest Taxation, March 2009

2578 Annette Bergemann and Regina T. Riphahn, Female Labor Supply and Parental Leave Benefits – The Causal Effect of Paying Higher Transfers for a Shorter Period of Time, March 2009

2579 Thomas Eichner and Rüdiger Pethig, EU-Type Carbon Emissions Trade and the Distributional Impact of Overlapping Emissions Taxes, March 2009

2580 Antonios Antypas, Guglielmo Maria Caporale, Nikolaos Kourogenis and Nikitas Pittis, Selectivity, Market Timing and the Morningstar Star-Rating System, March 2009

2581 António Afonso and Christophe Rault, Bootstrap Panel Granger-Causality between Government Budget and External Deficits for the EU, March 2009

2582 Bernd Süssmuth, Malte Heyne and Wolfgang Maennig, Induced Civic Pride and Integration, March 2009

2583 Martin Peitz and Markus Reisinger, Indirect Taxation in Vertical Oligopoly, March 2009

2584 Petra M. Geraats, Trends in Monetary Policy Transparency, March 2009

2585 Johannes Abeler, Armin Falk, Lorenz Götte and David Huffman, Reference Points and Effort Provision, March 2009

2586 Wolfram F. Richter, Taxing Education in Ramsey's Tradition, March 2009

2587 Yin-Wong Cheung, Menzie D. Chinn and Eiji Fujii, China's Current Account and Exchange Rate, March 2009

2588 Alexander Haupt and Silke Uebelmesser, Voting on Labour-Market Integration and Education Policy when Citizens Differ in Mobility and Ability, March 2009

2589 Hans Jarle Kind, Marko Koethenbuerger and Guttorm Schjelderup, Should Utility-Reducing Media Advertising be Taxed?, March 2009

2590 Alessandro Cigno, How to Avoid a Pension Crisis: A Question of Intelligent System Design, March 2009

2591 Helmut Lütkepohl and Fang Xu, The Role of the Log Transformation in Forecasting Economic Variables, March 2009

2592 Rainald Borck, Hyun-Ju Koh and Michael Pflüger, Inefficient Lock-in and Subsidy Competition, March 2009

2593 Paolo M. Panteghini, On the Equivalence between Labor and Consumption Taxation, March 2009

2594 Bruno S. Frey, Economists in the PITS?, March 2009

2595 Natalie Chen and Dennis Novy, International Trade Integration: A Disaggregated Approach, March 2009

2596 Frédérique Bec and Christian Gollier, Term Structure and Cyclicity of Value-at-Risk: Consequences for the Solvency Capital Requirement, March 2009

2597 Carsten Eckel, International Trade and Retailing, March 2009

2598 Gianni De Nicolò and Iryna Ivaschenko, Global Liquidity, Risk Premiums and Growth Opportunities, March 2009

2599 Jay Pil Choi and Heiko Gerlach, International Antitrust Enforcement and Multi-Market Contact, March 2009

2600 Massimo Bordignon and Guido Tabellini, Moderating Political Extremism: Single Round vs Runoff Elections under Plurality Rule, April 2009

2601 Ana B. Ania and Andreas Wagener, The Open Method of Coordination (OMC) as an Evolutionary Learning Process, April 2009

2602 Simon Gächter, Daniele Nosenzo, Elke Renner and Martin Sefton, Sequential versus Simultaneous Contributions to Public Goods: Experimental Evidence, April 2009

2603 Philippe Jehiel and Andrew Lilico, Smoking Today and Stopping Tomorrow: A Limited Foresight Perspective, April 2009

2604 Andreas Knabe, Steffen Rätzel, Ronnie Schöb and Joachim Weimann, Dissatisfied with Life, but Having a Good Day: Time-Use and Well-Being of the Unemployed, April 2009

2605 David Bartolini and Raffaella Santolini, Fiscal Rules and the Opportunistic Behaviour of the Incumbent Politician: Evidence from Italian Municipalities, April 2009

2606 Erkki Koskela and Jan König, Can Profit Sharing Lower Flexible Outsourcing? A Note, April 2009

2607 Michel Beine, Frédéric Docquier and Çağlar Özden, Diasporas, April 2009

2608 Gerd Ronning and Hans Schneeweiss, Panel Regression with Random Noise, April 2009

2609 Adam S. Booij, Bernard M.S. van Praag and Gijs van de Kuilen, A Parametric Analysis of Prospect Theory's Functionals for the General Population, April 2009

2610 Jeffrey R. Brown, Julia Lynn Coronado and Don Fullerton, Is Social Security Part of the Social Safety Net?, April 2009

2611 Ali Bayar and Bram Smeets, Economic, Political and Institutional Determinants of Budget Deficits in the European Union, April 2009

2612 Balázs Égert, The Impact of Monetary and Commodity Fundamentals, Macro News and Central Bank Communication on the Exchange Rate: Evidence from South Africa, April 2009

2613 Michael Melvin, Christian Saborowski, Michael Sager and Mark P. Taylor, Bank of England Interest Rate Announcements and the Foreign Exchange Market, April 2009

2614 Marie-Louise Leroux, Pierre Pestieau and Gregory Ponthiere, Should we Subsidize Longevity?, April 2009

2615 Ronald MacDonald, Lukas Menkhoff and Rafael R. Rebitzky, Exchange Rate Forecasters' Performance: Evidence of Skill?, April 2009

2616 Frederick van der Ploeg and Steven Poelhekke, The Volatility Curse: Revisiting the Paradox of Plenty, April 2009

2617 Axel Dreher, Peter Nunnenkamp, Hannes Öhler and Johannes Weisser, Acting Autonomously or Mimicking the State and Peers? A Panel Tobit Analysis of Financial Dependence and Aid Allocation by Swiss NGOs, April 2009

2618 Guglielmo Maria Caporale, Roman Matousek and Chris Stewart, Rating Assignments: Lessons from International Banks, April 2009

2619 Paul Belleflamme and Martin Peitz, Asymmetric Information and Overinvestment in Quality, April 2009

2620 Thomas Dohmen, Armin Falk, David Huffman and Uwe Sunde, Are Risk Aversion and Impatience Related to Cognitive Ability?, April 2009

2621 Yin-Wong Cheung and Xingwang Qian, The Empirics of China's Outward Direct Investment, April 2009

2622 Frédérique Bec and Christian Gollier, Assets Returns Volatility and Investment Horizon: The French Case, April 2009

2623 Ronnie Schöb and Marcel Thum, Asymmetric Information Renders Minimum Wages Less Harmful, April 2009

2624 Martin Ruf and Alfons J. Weichenrieder, The Taxation of Passive Foreign Investment – Lessons from German Experience, April 2009

2625 Yao Li, Borders and Distance in Knowledge Spillovers: Dying over Time or Dying with Age? – Evidence from Patent Citations, April 2009

2626 Jim Malley and Ulrich Woitek, Technology Shocks and Aggregate Fluctuations in an Estimated Hybrid RBC Model, April 2009

2627 Jin Cao and Gerhard Illing, Endogenous Systemic Liquidity Risk, April 2009

2628 Thiess Buettner and Bjoern Kauder, Revenue Forecasting Practices: Differences across Countries and Consequences for Forecasting Performance, April 2009

2629 Håkan Selin, The Rise in Female Employment and the Role of Tax Incentives – An Empirical Analysis of the Swedish Individual Tax Reform of 1971, April 2009

2630 Nick Johnstone and Ivan Hascic, Environmental Policy Design and the Fragmentation of International Markets for Innovation, April 2009

2631 Spiros Bougheas, Richard Kneller and Raymond Riezman, Optimal Education Policies and Comparative Advantage, April 2009

2632 Jay Pil Choi and Heiko Gerlach, Multi-Market Collusion with Demand Linkages and Antitrust Enforcement, April 2009

2633 Thor O. Thoresen, Income Mobility of Owners of Small Businesses when Boundaries between Occupations are Vague, April 2009

2634 Guido Schwerdt and Amelie C. Wuppermann, Is Traditional Teaching really all that Bad? A Within-Student Between-Subject Approach, April 2009

2635 Kurt R. Brekke, Luigi Siciliani and Odd Rune Straume, Hospital Competition and Quality with Regulated Prices, April 2009