How Price Regulation affects Quality in a Mixed Oligopoly: The Hospital Sector

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July 2009

Abstract

This paper derives a two-stage model of hospital competition under price regulation and full insurance protection. In the first stage the regulator determines the prices for treatment and in the second stage hospitals observe the treatment fee and compete by setting their treatment quality. The resulting subgame-perfect equilibrium in private oligopoly is compared with equilibrium in a mixed oligopoly, where private profit maximizing firms face competition with non-profit hospitals. Comparing prices which depend on the market equilibrium in the second stage and emerge from different objective functions of the regulator leads to qualitative identical results. The utility of the indifferent patient in private and mixed market regime is identical. Health expenditures however are lower in mixed oligopoly and decline in degree of non-profit orientation. Moreover both hospital types - profit-maximizing and non-profit - produce higher quality at a given price in mixed oligopoly equilibrium. Therefore privatization of hospitals reduces expenditures of the privatizing authorities but increases the expenditure of the insurance system.

Keywords: non-profit, quality competition, mixed oligopoly, price regulation

JEL: L31, I18

1. Introduction

As health expenditure, especially for inpatient care, increased dramatically over the last decades, the German government introduced a prospective reimbursement system for hospital services, based on Diagnosis Related Groups (DRG). The DRG's provide a basis for classifying heterogenous diagnosis and merge them in groups which then determine the capitation fee a hospital receives for the treatment.

The intention of introducing a DRG based reimbursement system was the implementation of incentives to avoid unnecessary treatment or measures and the reduction of the average length of stay, because the prices are fix and exogenous. This should allow to treating the same number of patient and simultaneously reducing health expenditures.

But these fix capitation fees of a prospective reimbursement system might also create incentives for hospitals to reduce costs, which in turn could lead to lower treatment quality. To counter these incentives, competition between hospitals should be improved in order to establish a countervailing element against quality reduction by the hospitals. More competition between hospitals should guarantee the reduction of health expenditures on the one hand and on the other hand, keep up or even improve social welfare.

Literature on hospital competition is quite comprehensive. Most studies consider quality to be the competition dimension for prices for hospital services are in most countries regulated. Especially in Germany, other parameters are hardly conceivable. Here, not only the prices are regulated by the DRG based capitation fees, but also e.g. a basic mix of diagnoses that must be treated by every hospital or the number of beds are regulated. Moreover, investments for hospitals which are inscribed in the so called "Krankenhausplan der Länder" are partly borne by governmental subsidies.

Theoretical literature mostly approaches hospital competition by using a model of spatial competition based on Hotelling (1929). Brekke et al. (2006) derive a three-stage game of hospital competition under regulated prices. In a first stage, a welfare maximizing regulator defines a price for hospital treatment. After observing the

price choice, the hospitals choose their location simultaneously in the second step and finally they make their treatment quality decision. According to Brekke et al., the hospitals are able to influence the intensity of competition by choosing their location. Moreover equilibrium outcome depends on how strong commitment power of the regulator is. If the regulator sets a final price in the first stage the market result is only second best, whereas with a regulator changing the price during the game a first-best solution could be reached. Assuming exogenous hospital location, Montefiori (2005) analyzes quality competition among hospitals under complete and asymmetric information. He uses a model in which hospitals compete in terms of quality and prices are regulated. He derives the price which guarantees hospital care for each patient and minimizes health expenditures. In a second step, he shows that asymmetric information, i.e. patient cannot observe the actual quality levels, does not change the equilibrium outcome.
Calem and Rizzo (1994) assume that hospitals compete by choosing a service mix and quality level. Results show that competition induces too high or insufficient levels of specialization, a monopolistic hospital however leads to a social optimum which implies positive effects of hospital mergers. A very similar result is provided by Brekke (2000). He derives that the quality level in equilibrium is too high or insufficiently low, but quality competition has unambiguously positive effects on quality level and quantity.

Like the models mentioned above, most theoretic papers on hospital competition only consider competition between private profit maximizing hospitals (in the following referred to as for-profit hospitals), in most countries however hospital markets are characterized by the existence of both, for-profit and not-for-profit hospitals, especially in Germany. The German hospital market is characterized by several different ownership types, private, public or municipal hospitals as well as different charitable hospitals, held by churchly or other charitable institutions. Occasionally, also cooperative hospitals could be observed. While almost all private hospitals are profit maximizing, the objectives of the other ownership types are more welfare orientated. Objectives, for example, could be the comprehensive provision of health services or providing health services especially to disadvantaged population groups.

All but private hospitals however have in common that they primarily are not profit orientated, hence they are subsumed under the term non-profit hospitals.

While mixed oligopoly in hospital markets has been widely ignored in theoretical research, this phenomenon was analyzed for other markets. One general model from Sanjo (2007) examines a market where profit maximizing firms compete with welfare maximizing ones. They show that no subgame perfect equilibrium exists if the sequence of decisions is location, quality and subsequently prices. Ishibashi and Kaneko (2008) describe a market where for-profit and non-profit coexist and the non-profit firm maximizes a weighted combination of profit and welfare. In this framework, they analyze the market outcome under full and partial privatization of the non-profit firm. Neumann and Reichel (2006) apply a simple Cournot framework on the German banking sector and derive market equilibrium where non-profit banks try to break even and not maximize their profits.

Empirical analyzes of mixed hospital competition is much more abundant. Gowrisankaran and Town (1997) estimate effects of reimbursement systems, insurance system and taxation on market outcomes in the hospital sector. Their results show clearly that it is optimal that non-profit hospitals exist, but effects of a comprehensive health insurance are ambiguous, depending on financing. Lastly they point out that taxation of non-profit hospitals could lower their incentive to provide an inefficiently high level of quality. McClellan and Staiger (1999) tested outcome quality of for-profit and non-profit hospitals and find that there could be evidence that non-profit hospitals produce higher quality, but that ownership per se does not determine the quality level since other factors like location could be of importance. Also Gaynor and Vogt (2003) estimated the ownership effect on market results in a mixed hospital oligopoly. An overview on empirical literature on competition between for and non-profit hospitals is provided by Eggleston et al. (2008).

One distinctive attribute in German hospital sector was that many municipal hospitals have been privatized within the last years and simultaneously private hospital expanded rapidly. One reason for privatization was to unburden public budgets. Moreover, it was claimed that private managed hospitals were more efficient and able to work more competitive than public non-profit hospitals. Hence, they should be able to provide higher quality at a given price. Incentives however are not clear. As the objective of private hospitals is to maximize their profits there might be incentives to reduce quality in order to reduce costs and raise profits. But also the prediction that private managed hospitals are more competitive is not compulsory. Herr (2008) for example investigated the cost and technical efficiency of German hospitals with respect to ownership types. She posits that public hospitals are most efficient in that sense.

This paper tries to develop a model of mixed oligopoly in hospital markets under price regulation and analyzes the welfare effects when non-profit hospitals exist under different objectives of the regulator. The paper is structured as follows: Chapter two derives a model of private duopoly, i.e. competition among profit maximizing hospitals, as a benchmark. In chapter three the basic model is modified to a mixed oligopoly where a profit maximizing hospital faces competition with a non-profit one. Chapter four compares the results.

2. Private Duopoly

The analysis applies a simple Model of spatial competition. Two hospitals exogenously located at the end of an interval $[0,1]$ serve a spatial market for hospital services with a prospective reimbursement scheme. For each treatment, a hospital gets a fixed capitation fee p. For simplification, it is assumed that hospitals only treat one identical diagnosis. For patients are fully insured, the costs for treatment are carried by the health insurance company. The patients' willingness to pay therefore does not affect the patients demand for treatment.

Demand

The patients are uniformly distributed in the interval $[0,1]$. In case of illness patients choose treatment in one of the two hospitals. Patients choose treatment in that hospital which creates higher utility according to the following utility function

$$U(x,d) = \begin{cases} x_i - \gamma d \\ x_j - \gamma(1-d) \text{ with } \gamma > 0. \end{cases} \quad (1)$$

Thus, the patients' utility depends positively on the treatment quality x and negatively on the distance d (between the own and the hospital's location) and the factor γ, representing the transport costs. A patient only chooses treatment in a hospital if her utility is greater or equal to zero, i.e. $x_i \geq \gamma d$.

This location of the marginal patient, which is indifferent between treatment in either hospital i or j could be achieved by the condition

$$x_i - \gamma d = x_j - \gamma(1-d).$$

Solving the indifference condition for d derives the location of the marginal patient and due to the distribution assumption directly to demand of hospital i

$$d = \frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2} = q_i. \quad (2)$$

According to Eq. (2) market share q decreases in transport costs γ and distance d. In turn it increases in difference between own and competitors quality level.

Costs

Being able to provide a certain quality level, a hospital has to bear several costs. On the one hand, the quality level itself incurs expenses for being reached or kept up, on the other hand, every treated patient causes costs, depending on quality level. Hence, the following cost function is assumed

$$C_i(q_i, x_i) = cx_i^2 + x_i q_i, \quad (3)$$

The coefficient c represents a constant cost parameter for reaching a certain quality level. Total costs consist of costs for quality level and costs for each patient treated at a certain quality level. Marginal costs of quality are increasing, which means decreasing returns to scale with respect to quality whereas the returns to scale with respect to quantity are constant.

2.1. Stage 2: Quality Choice

To make results of a mixed hospital oligopoly comparable first of all, an oligopoly with only profit maximizing firms is derived as a reference point. I apply a two stage game where in the first stage, the regulator sets the capitation fee for treatment and in the second step, the hospitals simultaneously choose their quality level at a given price. The market game is solved by backward induction, first solving the market game in stage two and subsequently solving the regulator's price choice if she is able to anticipate the hospitals' quality choice. The price the regulator sets strongly depends on her objective function. In the following, three regulator's objectives are assumed: assurance of health service to the whole population and welfare maximization in an utilitarian and Rawlsian sense.

According Eq. (2), demand of hospital i for treatment is

$$q_i = \frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2}.$$

With respect to this demand, the cost function is

$$\begin{aligned} C(q_i, x_i) &= cx_i^2 + x_i q_i \\ &= cx_i^2 + x_i \left[\frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2} \right] \end{aligned}$$

and thus, the profit function of hospital i is

$$\pi_i = p\Big(\frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2}\Big) - cx_i^2 - x_i \left[\frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2} \right].$$

Maximizing profits with respect to x_i leads to the first order condition

$$\frac{\partial \pi_i}{\partial x_i} = \frac{p}{2\gamma} - \frac{2x_i - x_j}{2\gamma} - 2cx_i - \frac{1}{2} = 0$$

and thus derives the reaction function of hospital i

$$x_i(x_j) = \frac{x_j + p - \gamma}{4c\gamma + 2}.$$

Computing the reaction function of hospital j analogously because of the symmetric game and solving the equation system leads to the Nash-equilibrium qualities

$$x_i^* = x_j^* = \frac{p - \gamma}{4c\gamma + 1} \tag{4}$$

which depend on the price set by the regulator in stage one. Due to symmetry and identical quality levels, both hospitals serve half of the market in equilibrium, so

$$q_i^* = q_j^* = \frac{1}{2}. \tag{5}$$

The equilibrium quality level, given in Eq. 4, increases in prices p and declines in transport costs γ and cost parameter c, assuming that $p > c$ (see Appendix A).

2.2. Stage 1: Price Regulation

Anticipating the hospitals quality choice, the regulator sets the treatment fee in order to meet her objective function. Three possible objectives of the regulator are conceivable and discussed in literature. Suppose the Regulator wants to minimize social costs with the constraint of guaranteeing treatment to all individuals, she sets a price which makes the marginal patient indifferent between treatment and no treatment, i.e. her utility is greater than or equal to zero (see e.g. Montefiori (2005)).

If welfare instead of costs drives the regulator, two different possibilities can be imagined. The regulator could maximize welfare in a sense of Rawls (1971) which means that she maximizes utility of the individual with the lowest utility (i.e. the indifferent patient) or social welfare is maximized, which in the following is the sum of consumers' and producers' surplus. Equlibrium quality and treatment price for all three cases are derived in the next section.

Service Guarantee

The whole population is provided with health service if the indifferent patient chooses treatment. Setting the price under that condition entails minimal costs for comprehensive health service. Combining Eq. (1) and (5) leads to utility of the indifferent patient

$$x_i - \frac{\gamma}{2} \geq 0.$$

Including Nash-equilibrium quality according Eq. (4) gives

$$\frac{p - \gamma}{4c\gamma + 1} - \frac{\gamma}{2} \geq 0.$$

Solving this participation condition with respect to p leads to a price p^S which guarantees health service to all patients

$$p^S = \frac{4c\gamma^2 + 3\gamma}{2}.$$

Given this price, the hospitals provide equilibrium quality

$$x_i^S = \frac{\gamma}{2} \tag{6}$$

and marginal patient's utility is zero.

Welfare maximization

If, in contrast, the regulator sets the price to maximize a utilitarian social welfare function, the regulator's objective function is

$$\max_p W = \int_0^{\bar{q}} (x_i - \gamma q_i) dq_i + \int_{\bar{q}}^1 (x_j - \gamma q_j) dq_j + \pi_i + \pi_j, \quad \text{with} \quad \bar{q} = \frac{1}{2}$$

$$= \int_0^{\frac{1}{2}} (x_i - \gamma q_i) dq_i + \int_{\frac{1}{2}}^1 (x_j - \gamma q_j) dq_j + 2\left[\frac{p}{2} - c(\frac{p-\gamma}{4c\gamma+1})^2 - \frac{1}{2}(\frac{p-\gamma}{4c\gamma+1})\right]$$

Maximizing W and solving the first order condition

$$\frac{\partial W}{\partial p} = 2\left[\frac{1}{2} - \frac{2c(p-\gamma)}{(4c\gamma+1)^2} - \frac{1}{(8c\gamma+2)}\right] + \frac{8}{32c\gamma+8} = 0$$

for p, the welfare maximizing price

$$p^W = \frac{16c^2\gamma^2 + 12c\gamma + 1}{4c} \tag{7}$$

results. Given p^W the equilibrium qualities are

$$x_i^W = x_j^W = \frac{4c\gamma+1}{4c}.$$

Equilibrium qualities at the welfare maximizing price of course exceed quality at a price which guarantees treatment at lowest possible costs, since

$$x^W = \frac{4c\gamma+1}{4c} > \frac{\gamma}{2} = x^S,$$

but are also accompanied by higher social costs, since p^W exceeds p^S

$$p^W = \frac{16c^2\gamma^2 + 12c\gamma + 1}{4c} > \frac{4c\gamma^2 + 3\gamma}{2} = p^S.$$

The utility of the indifferent patient then is

$$U_I^W = \frac{2c\gamma+1}{4c} \tag{8}$$

which is greater than zero, i.e. the utility at service guaranteeing price.

3. Mixed Oligopoly

Now, knowing the market results in private duopoly, a non-profit player is introduced and market outcomes in mixed oligopoly are analyzed. In the following mixed oligopoly, the profit maximizing hospital competes against a non-profit one. While the private hospital still maximizes profits, its competitor follows other objectives. Non-profit objectives have been widely discussed. For example, Newhouse (1970), Gaynor and Vogt (2003) or Calem et al. (1999) assume that a non-profit hospital maximizes the total number of patients treated. Other authors, however, assume that non-profit firms maximize quality or welfare, but also mixed objectives, where non-profit firms maximize a weighted mix of profit and another objective, have been discussed. Ishibashi and Kaneko (2008) analyze a market where a profit maximizing firm competes with a mixed objective non-profit firm. An overview of non-profit objectives is provided by Harrison and Lybecker (2005), Horwitz and Nichols (2007) or Fraja and Delbono (1990).

In the following, I will apply a model where a non-profit firm maximizes a weighted mix of market share and profits in order to maximize health provision. Most of the in our sense non-profit hospitals are municipal or state owned hospitals. Their legal mandate is health care provision which could exculpate the assumption of market share maximization. Moreover as public budgets are under pressure also the profit part of the objective could be hold.

3.1. Stage 2: Quality Choice

Again, the two stage game is solved by backwards induction, beginning with stage two in which the competitors determine their quality level. The non-profit hospital's objective function consists of the quantity with respect to the market share and the profits, weighted with factor α. If α converges to one, the objective is a perfect non-profit one, if it converges to zero the objective is equal to the profit maximizing hospital. Hence, the optimization problem of the non-profit hospital is

$$\max_{x_i} V_i = q_i + \pi_i$$
$$= \alpha\left[\frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2}\right] + (1-\alpha)\left[p\left(\frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2}\right) - cx_i^2 - x_i\left[\frac{1}{2\gamma}(x_i - x_j) + \frac{1}{2}\right]\right].$$

Differentiating V_i with respect to its quality x_i gives

$$\frac{\partial V_i}{\partial x_i} = \frac{\alpha}{2\gamma} + (1-\alpha)\left[\frac{p}{2\gamma} - \frac{2x_i - x_j}{2\gamma} - 2cx_i - \frac{1}{2}\right] = 0.$$

Solving for x_i derives the reaction function of the non-profit hospital

$$x_i(x_j) = \frac{(1-\alpha)x_j + (1-\alpha)p - (1-\alpha)\gamma + \alpha}{(4-4\alpha)c\gamma + 2 - 2\alpha}.$$

The profit hospital's reaction function is identical with the for-profit reaction function in chapter two

$$x_j(x_i) = \frac{x_i + p - \gamma}{4c\gamma + 2}.$$

Determining the Nash-equilibrium derives the following equilibrium qualities

$$x_i^* = \frac{[(4-4\alpha)c\gamma + 3 - 3\alpha]p - (4-4\alpha)c\gamma^2 - (3 - 3\alpha - 4\alpha c)\gamma + 2\alpha}{(16-16\alpha)c^2\gamma^2 + (16-16\alpha)c\gamma + 3 - 3\alpha} \tag{9}$$

for the non-profit and

$$x_j^* = \frac{[(4-4\alpha)c\gamma + 3 - 3\alpha]p - (4-4\alpha)c\gamma^2 - (3 - 3\alpha)\gamma + \alpha}{(16-16\alpha)c^2\gamma^2 + (16-16\alpha)c\gamma + 3 - 3\alpha} \tag{10}$$

for the profit hospital. The differences in quality show very easily that the non-profit produces higher quality in equilibrium than the for-profit hospital does, independently of the price since $x_i - x_j = \frac{\alpha}{(4-4\alpha)c\gamma+3-3\alpha}$.

Substituting $x_i - x_j$ in the demand function of hospital i, given by Eq. (2), gives the market share of the non-profit hospital

$$q_i^* = \frac{1}{2} + \frac{\alpha}{(8-8\alpha)c\gamma^2 + (6-6\alpha)\gamma} \tag{11}$$

and $(1 - q_i)$ the market share of the private hospital

$$q_j^* = \frac{1}{2} - \frac{\alpha}{(8-8\alpha)c\gamma^2 + (6-6\alpha)\gamma}. \tag{12}$$

PROPOSITION 1 *The more the non-profits focuses on the quantity-objective (i.e. the higher α is) the wider the difference between the results of mixed and private oligopoly.*

PROOF 1 *See Appendix B.1*

PROPOSITION 2

i) $x_i^* > x_j^* \quad \forall \quad \alpha \in (0,1)$. *The non-profit hospital produces higher quality than the profit maximizing hospital unless its objective function is driven entirely by the profit motive.*

ii) $q_i^* > q_j^* \quad \forall \quad \alpha \in (0,1)$. *Because of i) the non-profit serves a higher market share than the profit does.*

iii) $\frac{\partial(x_i^* - x_j^*)}{\partial\alpha} > 0$. *The quality difference increases in the non-profit coefficient.*

PROOF 2 *See Appendix B.2*

PROPOSITION 3 *In a mixed oligopoly, the quality of treatment of both hospitals, the non-profit as well as the profit hospital, is higher than in private oligopoly.*

PROOF 3 *See Appendix B.3*

3.2. Stage 1: Price Regulation

Service Guarantee

Now again, if the regulator wants to guarantee treatment to the whole population at lowest possible costs, she sets a price which makes the marginal patient indifferent that is her utility equals zero.

The marginal patient's utility according to Eq. (1) is $U = x_i - \gamma d = 0$, where $d = \frac{1}{2} + \frac{\alpha}{(8-8\alpha)c\gamma^2+(6-6\alpha)\gamma}$ and x_i is substituted by Eq. (9). Therefore the indifference condition is

$$\frac{[(4-4\alpha)c\gamma+3-3\alpha]p-(4-4\alpha)c\gamma^2-(3-3\alpha-4\alpha c)\gamma+2\alpha}{(16-16\alpha)c^2\gamma^2+(16-16\alpha)c\gamma+3-3\alpha}-$$
$$\gamma\left[\frac{1}{2}+\frac{\alpha}{(8-8\alpha)c\gamma^2+(6-6\alpha)\gamma}\right]=0.$$

Solving this condition for p derives the price which guarantees comprehensive treatment and minimizes costs

$$p^S=\frac{(4-4\alpha)c\gamma^2+(3-3\alpha)\gamma-\alpha}{2-2\alpha}.$$

Given this price, the hospitals provide the quality levels

$$x_i=\frac{(4-4\alpha)c\gamma^2+(3-3\alpha)\gamma+\alpha}{(8-8\alpha)c\gamma+6-6\alpha}$$

$$x_j=\frac{(4-4\alpha)c\gamma^2+(3-3\alpha)\gamma-\alpha}{(8-8\alpha)c\gamma+6-6\alpha}$$

which again leads to marginal patient's utility equal to zero.

Welfare maximization

A regulator which maximizes a social welfare function analogously to chapter two faces the following optimization problem

$$\max_p W=\int_0^{\overline{q}}(x_i-\gamma q_i)dq_i+\int_{\overline{q}}^1(x_j-\gamma q_j)dq_j+\pi_i+\pi_j,$$

where

$$\overline{q}=\frac{1}{2}+\frac{\alpha}{(8-8\alpha)c\gamma^2+(6-6\alpha)\gamma}$$

is the location of the indifferent patient. This leads to the first order condition

$$\frac{\partial W}{\partial p}=\frac{(16-16\alpha)c^2\gamma^2+(12-12\alpha)c\gamma-(4-4\alpha)cp+2\alpha c+\alpha-1}{(16-16\alpha)c^2\gamma^2+(8-8\alpha)c\gamma-\alpha+1}=0.$$

and finally to the welfare maximizing price

$$p^W = \frac{(16-16\alpha)c^2\gamma^2 + (12-12\alpha)c\gamma - 2\alpha c - \alpha + 1}{(4-4\alpha)c}. \tag{13}$$

Given this price, the equilibrium quality levels

$$x_i^W = \frac{(16-16\alpha)c^2\gamma^2 + (16-16\alpha)c\gamma + 3 - 3\alpha + 2\alpha c}{(16-16\alpha)c^2\gamma + (12-12\alpha)c}$$

and

$$x_j^W = \frac{(16-16\alpha)c^2\gamma^2 + (16-16\alpha)c\gamma + 3 - 3\alpha - 2\alpha c}{(16-16\alpha)c^2\gamma + (12-12\alpha)c}$$

lead to the utility of the marginal patient

$$U_I^W = \frac{2c\gamma + 1}{4c}. \tag{14}$$

Proposition 4

i) In both regimes, private and mixed oligopoly, the marginal patient's utility are equal.

ii) $p^W_{private} > p^W_{mixed} \quad \forall \quad \alpha \in (0,1)$. *The welfare maximizing price in mixed oligopoly is lower than in private oligopoly.*

iii) $\frac{\partial p^W_{mixed}}{\partial \alpha} < 0 \quad \forall \quad \alpha \in (0,1)$. *The welfare maximizing price declines in the non-profit coefficient* α.

Proof 4 *See Appendix B.4*

Proposition 5 *If the regulator maximizes welfare according to Rawls (1971), which means the maximization of the indifferent patient's utility as well as the hospitals' profits, the price set by the regulator equals the welfare maximizing price in Eq.* (7) *and* (13), *depending on the market regime.*

Proof 5 *See Appendix B.5*

4. Conclusion

Many western countries, including Germany, introduced a DRG-based prospective payment system with the intension to reduce health expenditures, increase transparency and raise hospitals' efficiency. As prices are set by a regulator, also the provision of higher quality of treatment for the patients should be achieved by quality competition.

The introduction was accompanied by the privatization of hospitals which should intensify these effects. Although the average length of stay and the number of beds has decreased, the health expenditures did not decline necessarily. On the one hand, this is owed to the fact that other factors but a lack of competition determine the expenditures. On the other hand, a private regime doesn't reduce the social costs per se.

In the second part of the paper, I set up a simple spatial competition framework to derive the competition outcome in a private regime as a benchmark. Hospitals compete in a spatial market where patient choose treatment in that hospital that provides them with the highest utility. In a private duopoly, where in a first step the regulator sets the capitation fee and in a second step, the hospitals simultaneously choose the treatment quality, both hospitals provide identical qualities in equilibrium and face the same demand. If the regulator chooses a price which guarantees treatment to all patients, the utility of the indifferent patient, which is the individual with the lowest utility, is equal to zero. The regulator has no incentive to choose a higher price if his objective is comprehensive health care at minimum cost.

If the regulator maximizes the welfare, i.e. the sum of consumers' and producers' surplus, the indifferent patient could reach a higher utility, but also the price has to be higher.

In the second part, a non-profit hospital exists. As non-profits accept lower or even zero profit margins in order to follow their objective function, the quality produced by the non-profit is higher than the equilibrium quality of the for-profit hospital and therefore, the for-profit hospital looses market share. Because of this asymmetry in equilibrium, the price chosen by the regulator is lower than in a private regime, whereas the regulator's objectives are also achieved. In both cases, service guarantee and welfare maximization, the indifferent patient's utility is equal, independent of the regime. But both cases lead to a lower price and hence, to lower health expenditures.

These results imply that privatizing municipal and state owned hospitals leads to lower social costs in the short run as potentially loss making hospitals have not to be sustained any longer, but in the long run, leads to higher treatment fees and therefore, just shifts the burden from taxpayers to the insured.

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A. Comparative Statics

To check the effects of changes in prices, cost parameters or transport costs on equilibrium qualities, the partial differentials are build.

$$\frac{\partial x^*}{\partial p} = \frac{1}{4c\gamma + 1} > 0,$$
$$\frac{\partial x^*}{\partial c} = -\frac{4\gamma(p-\gamma)}{(4c\gamma)^2} < 0 \quad \text{if} \quad p > \gamma,$$
$$\frac{\partial x^*}{\partial \gamma} = -\frac{4cp + 1}{16c^2\gamma + 8c\gamma + 1} < 0.$$

Equilibrium quality increases when the price increases and decreases when γ increases. The Reaction of quality to changes in the cost parameter is ambiguous. Quality increases if p exceeds γ, which could be assumed.

B. Proofs

B.1. Proof of Proposition 1

$$\lim_{\alpha \to 0} x_i(x_j) = \frac{(1-\alpha)x_j + (1-\alpha)p - (1-\alpha)\gamma + \alpha}{(4-4\alpha)c\gamma + 2 - 2\alpha} = \frac{x_i + p - \gamma}{4c\gamma + 2}$$

If α converges to zero, the non-profit hospital's reaction function equals the for-profit hospital's reaction function. Hence, the same Nash-equilibrium as in chapter two arises. Thus,

$$\lim_{\alpha\to 0} x_i^* = \frac{p-\gamma}{4c\gamma+1} = x_j^*,$$
$$\lim_{\alpha\to 0} q_i^* = \frac{1}{2} = q_j^*,$$
$$\lim_{\alpha\to 0} p^{cl} = \frac{4c\gamma^2+3\gamma}{2},$$
$$\lim_{\alpha\to 0} x_i^{cl} = \frac{\gamma}{2} = x_j^{cl} \quad \text{and}$$
$$\lim_{\alpha\to 0} p^W = \frac{16c^2\gamma^2+12c\gamma+1}{4c}$$

B.2. Proof of Proposition 2

i)

Since

$$x_i^* - x_j^* = \frac{\alpha}{(4-4\alpha)c\gamma+3-3\alpha} > 0, \quad \forall \quad \alpha \in (0,1)$$

the non-profit hospital provides higher quality in equilibrium.

ii)

Because of i) the market shares in equilibrium are

$$q_i^* = \frac{1}{2} + \frac{\alpha}{(8-8\alpha)c\gamma^2+(6-6\alpha)\gamma} > q_i^* = \frac{1}{2} - \frac{\alpha}{(8-8\alpha)c\gamma^2+(6-6\alpha)\gamma}.$$

Since $x_i^* > x_j^*$ and

$$\frac{\alpha}{(8-8\alpha)c\gamma^2+(6-6\alpha)\gamma} > 0 \quad \forall \quad \alpha \in (0,1)$$

the non-profit hospital always serves a higher market share.

iii)

Differentiating the quality difference with respect to the non-profit parameter α yields

$$\frac{\partial(x_i - x_j)}{\partial\alpha} = \frac{1}{(4\alpha^2-8\alpha+4)c\gamma+3\alpha^2-6\alpha+3} > 0.$$

Because the denominator is greater than zero for all $\alpha \in (0,1)$, the difference in quality levels increases in α.

B.3. Proof of Proposition 3

The quality provided in mixed oligopoly by both, the for-profit and the non-profit hospital, is higher than quality in private oligopoly, since

$$x^*_{non-profit-mixed} - x^*_{private} = \frac{4\alpha c\gamma + 2\alpha}{(16-16\alpha)c^2\gamma^2 + (16-16\alpha)c\gamma + 3 - 3\alpha} > 0 \quad \forall \quad \alpha \in (0,1)$$

$$x^*_{for-profit-mixed} - x^*_{private} = \frac{\alpha}{(16-16\alpha)c^2\gamma^2 + (16-16\alpha)c\gamma + 3 - 3\alpha} > 0 \quad \forall \quad \alpha \in (0,1)$$

B.4. Proof of Proposition 4

i)

According to Eq. 8 and 14, the indifferent patient's utility equals in both regimes

$$U^I_{private} = \frac{2c\gamma + 1}{4c} = U^I_{mixed}.$$

ii)

As long as one hospital is at least partly driven by the non-profit motive, the welfare maximizing price in mixed regime is lower than in private regime.

$$p^W_{private} = \frac{16c^2\gamma^2 + 12c\gamma + 1}{4c} > \frac{(16-16\alpha)c^2\gamma^2 + (12-12\alpha)c\gamma - 2\alpha, c - \alpha + 1}{(4-4\alpha)c} = p^W_{mixed}$$

for $\alpha \in (0,1)$.

iii)

Computing the differential of W with respect to α yields

$$\frac{\partial p^W_{mixed}}{\partial \alpha} = -\frac{1}{2\alpha^2 - 4\alpha + 2} < 0 \quad \forall \quad \alpha \in (0,1).$$

Because the denominator is greater than zero for al $\alpha \in (0,1)$ the welfare maximizing price decreases if α increases.

B.5. Proof of Proposition 5

In private oligopoly, the Rawlsian welfare function is $W = U_I + \pi_i + \pi_j$. This leads to the following optimization problem

$$\max_p W = \left[\frac{p-\gamma}{4c\gamma+1} - \frac{\gamma}{2}\right] + 2\left[\frac{p}{2} - c\left(\frac{p-\gamma}{4c\gamma+1}\right)^2 - \frac{1}{2}\left(\frac{p-\gamma}{4c\gamma+1}\right)\right].$$

Solving the first order condition

$$\frac{\partial W}{\partial p} = -\frac{4cp - 16c^2\gamma^2 - 12c\gamma - 1}{16c^2\gamma^2 + 8c\gamma + 1} = 0.$$

with respect to p derives

$$p^R = \frac{16c^2\gamma^2 + 12c\gamma + 1}{4c} = p^W.$$

In mixed oligopoly, the welfare function is similar to the one above.

$$W = U_I + \pi_i + \pi_j.$$

Solving again the first order condition

$$\frac{\partial W}{\partial p} = -\frac{(4\alpha-4)cp + (16-16\alpha)c^2\gamma^2 + (12-12\alpha)c\gamma - 2\alpha c - \alpha + 1}{(16\alpha-16)c^2\gamma^2 + (8\alpha-8)c\gamma + \alpha - 1} = 0$$

with respect to p gives

$$p^R = \frac{(16-16\alpha)c^2\gamma^2 + (12-12\alpha)c\gamma - 2\alpha c - \alpha + 1}{(4-4\alpha)c} = p^W.$$