



Hospitals Quality Competition and Specialization Choice under Regulated Price

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Abstract

Non-price competition strategy is a major health policy concern in many countries. This paper studies the treatment specialization choice and quality level competition among hospitals. We extend a two-stage spatial duopoly model, with the partially altruistic providers firstly choosing specialization and then determining quality level when the treatment price is set exogenously by central planner. The first best conclusion of quality is that two hospitals always invest equally much in quality, which suggests the “quality weapon” between hospitals in reality. Then, specialization-quality equilibrium gives the conclusion that quality competition introduces a centrifugal effect in the specialization game. And with the unmatched cost between patients disease and hospital’s specialization is lower, hospitals’ equilibrium quality level and specialization differentiation will decrease.

Keywords: Hospital, Quality, Specialization

1. Introduction

Hospitals are recently undergoing growing pressure to improve the quality of their service and quality is the basic dimension to competition. Hospital care is vertically differentiated by quality and horizontally differentiated according to specialization it is professional in (Kesteloot, 1998, pp.701-728). Patients’ being troubled in some kinds of disease, and they choose the hospitals of high quality and reputation and meantime those are good at curing their disease. Comprehensive hospitals with advanced equipment, skilled physicians, good reputation are capable of handling complex diseases. However, unmatched between disease and hospitals’ profession is costly, particularly for patients of high risk. So, there is a tradeoff between unmatched cost and service quality when patients choose where they will choose to accept service.

In China, hospital care industry has undergoing considerable changes since 1980s. The major problems China’s health sector today faces lie in the widespread inefficiency and inequity in resource use, as well as the rapid cost increase in health care. One of the most important measure taken by Chinese government is price regulation. The prices paid by fee-paying patients are set by government, with the dominant concern being to make sure that basic services are affordable to the whole population. At the heart of the issue of pricing policy in the Yellow Book price list-a detailed listing of thousands of medical procedures, services and diagnostic tests. Prices have tended to be set below cost for simple and non-invasive care and above cost for more complex care. The intention is that patients who need basic care receive it. So, the dominant concern for hospital manager in strategy is not price competition, while it is specialization choose and how much to invest in quality improving.

To study competition between hospitals, Xavier(2003, pp.25-51) and Siciliani(2005, pp.201-215) model competition within a Hotelling framework and in a duopoly model with differentiated products respectively. Existing models of competition and regulated prices are not fully adequate for assessing the impact of China’s reforms, because they are not tailored to be institutional features of the health sector (Karen, 2004). The aim of our paper is to study hospitals competition when patients disease are distributed on a line and hospitals compete for both the optimal specialization and quality level. We shall assume that prices are regulated by central planner. We also consider the heterogeneous patients demand, partly benevolent providers and convex costs that are non-separable in activity and quality.

2. The model

2.1 Patients choice

To analyze competition and interaction among hospitals, we extend the Hotelling framework (Hotelling, 1929, pp.41-57) and refer to the different variables and parameters of the model in terms of health care market. Although the model is a

variant of the well-known spatial economics, it is frequently applied to analyze product differentiation and specialization choice (Eaton, 1975, pp.27-49). We consider a regional market for health care where each of two hospitals, indexed by $i=1,2$, choose a location and a quality level on the unit line $[0,1]$ (assuming $x_1 < x_2$). On this line segment, there is a uniform distribution of patients with heterogeneous diseases, with total mass normalized to 1. Assuming full market coverage, the decision patients make is to choose which hospital to demand treatment from. Here, we can interpret the patients' location as the specialization of disease or the level of severity she suffers from, and the two hospitals are differentiated with their profession. The utility derived by the patient who is located at z seeking treatment at hospital i at x_i is given by

$$U(z, x_i, q_i) = v + q_i - t|z - x_i| - p \tag{1}$$

Where v is the gross valuation of medical treatment, which is assumed to be equal to all patients. q_i is the quality provided by hospital i , that is to say the quality level is one the major concern for patients to choose where to go; t is a travelling cost parameter, which is also interpreted with association with the cost of inappropriate match between services the hospitals provide and patients need (Calem, 1995, pp.1182-1198; Brekke, 2007, pp.147-170). p is the service fee charged to patients, also known as out-of-pocket money, and in the health care, it is fixed to the patient of the same insurance type.

The location \bar{z} of patient (specialization or severity of disease) who is indifferent between getting service from either hospital is given by:

$$q_1 - t|\bar{z} - x_1| = q_2 - t|x_2 - \bar{z}| \tag{2}$$

Therefore,

$$\bar{z} = \frac{1}{2}(x_1 + x_2) + \frac{q_1 - q_2}{2t} \tag{3}$$

Total demand facing hospital i identified as D_i is given by $D_1 = \bar{z}$ and $D_2 = 1 - \bar{z}$. The demand here is defined as the number of cases, regardless of all differences in case-mix. To future analyze the demand reacts to the changes in specialization and quality of the hospital, we get

$$\frac{\partial D_1}{\partial q_1} = \frac{1}{2t(x_2 - x_1)} > 0, \frac{\partial D_1}{\partial q_2} = -\frac{1}{2t(x_2 - x_1)} > 0, \frac{\partial^2 D_1}{\partial q_1 \partial t} = -\frac{1}{2t^2(x_2 - x_1)} > 0 \tag{4}$$

Notice that demand increases with the improvement of quality, and decreases with the improvement of quality in counterpart. It is the fact that when price is regulated, hospitals may have a strong incentive to engage in non-price e.g. quality competition, and quality effort may further has a negative spillover effect to the demand of rival hospital. For example, hospital 1 purchasing a CT-scanner, may induce some of hospital 2's patients to opt for hospital 1, so the quality is then said to have a market expansion effect (Shaked and Sutton, 1990, pp.45-62). Further, higher matching cost decrease the demand responsiveness to changes in quality of services.

2.2 Hospital objective function

The hospitals' objective function needs to be specified. In China, most of high level hospitals have a not-for-profit status and are public established, also it is not very proper to assume that hospitals in China aim at profit maximizing. Therefore, we consider a provider who cares about the benefits patients get from treatment as well as the net revenue hospital get and disutility because of cost (Ellis and McGuire, 1986, pp.192-151; 1990; Glaze and McGuire, 1994):

$$U = \beta B(\cdot) + \Pi_i = \beta B(\cdot) + R_i - C_i \tag{5}$$

The function $B(\cdot)$ refers to the benefit patients get from treatment in hospital i . The parameter $\beta \in (0,1)$ suggests the degree of altruism the hospital is. The higher β , the more benevolent the provider is. A provider who equally benefit of patients and net revenue would have β equal to one, while a profit-maximizing hospital set $\beta = 0$ (Ellis, 1986, pp.129-151; Chalkley, 1998, pp.1-19). The benefit of patients in hospital 1 is given by:

$$B_1(\cdot) = \int_0^{\frac{1}{2}(x_1+x_2) + \frac{q_1-q_2}{2t}} [v + q_1 - t|z - x_1| - p] dz \tag{6}$$

The benefit of patients from hospital 2 is of the same form. Yielding,

$$\frac{\partial B_1}{\partial q_1} = \frac{1}{2t}(v + q_1 - p) + \frac{1}{4}(x_2 - x_1) + \frac{q_1 - q_2}{4t} > 0 \tag{7}$$

So, as the quality of service improve, patients benefit more in that it has two kind of effect. First, it increases per

patient's benefit from treatment, which is represented by the first term in Eq(7); second, it attracts more patients to get treatment in hospital i , which is shown by the second term of Eq(7).

Besides,

$$\frac{\partial^2 B_i}{\partial^2 q_i} = \frac{3}{4t} > 0 \tag{8}$$

With regard to hospitals income, an important part of hospital returns does not come from patient out-of-patient payments, but from health insurance companies. Usually, the insurer of health plan pays the provider a prospective payment p (net of any fixed costs), plus a reimbursement per service of δ (positive or negative) above variable cost c , that is to say, additional fee per service is $\delta + c$. In China, fee-for-service (FFS) payment is mostly applied under some other constraints such as global budget(Liu, 1998). In this case, A FFS payment system with a positive profit margin per service would be represent by $p = 0$ and $\delta + c > c$. While, under prospective financing the reimbursement is not based on the actual costs, and the hospital are reimbursed under a fixed amount of monger per case, for instance a flat prospective payment, which gains popularity in OECD countries, corresponds to $p > 0$ and $\delta + c = 0$. Providers' quality or behavior incentive under either retrospective or prospective or a mixture of both financing mechanism is widely studied, so this paper focus on the FFS payment system which is more accordance with Chinese reality.

The marginal cost of production is assumed to be independent of specialization of service and determined by quality level. So the total cost consists of two part, usual cost generated by providing service and improving quality, and total cost is increasing in both quantity and quality.

$$C_i = C_i(D_i, q_i) \tag{9}$$

We assumes that cost is increasing and strictly convex with demand of treatment because of the capacity restrict and convex with the improvement of quality in that quality improving efforts are modeled as involving diminishing returns, specified as increasing marginal costs of providing higher quality. The higher quality level a hospital has already reached, the more difficult it becomes to still improve on quality. Also, we assume $C_{Dq} \geq 0$, that is to say quality and quantity are complements: an increase in quality is more costly when more patients are treated (Brekke, 2008).

Thus, the net revenue hospital i gains can be described as

$$\text{FFS: } \Pi_i = R_i - C_i = (\delta + c)D_i - C_i = \delta D_i - C_i(q_i) \tag{10}$$

where $C_i(q_i)$ is the cost only to improve quality.

The timing in the model is as followings: The hospitals simultaneously choose the specialization; Then provider choose the quality level and patients choose treatments in response.

3. Equilibrium

The game with more than one stage is usually solved by backward induction. So we begin with analyze the Nash equilibrium result of hospital's quality level for a given specification and then for the choice of specification.

3.1 Quality competition

The first choice for the hospital to determine quality level is as the following function:

$$\beta B'(\cdot) - C'(q_i) = -\frac{\delta}{2t} \tag{11}$$

And the condition of the second order is $-C''(q_i) + \beta B''(\cdot) < 0$, that is to insure the existence of equilibrium, $C''(q_i)$ which is above 0 has a lowest bound. Using our assumption that $C''(q_i)$ is increasing and strictly convex, thus, the quality of hospital 1 must be over the lowest bound.

Because of the symmetric form of two hospitals' location choice and utility function, two hospitals always invest equally much is quality, which is common and rational when price is regulated. Quality of service is the 'competition weapon' for hospitals to attract more patient and to get larger market share. The result conform to Brekke's research (Brekke, 2006, pp.207-227).

$$\frac{\partial q_i}{\partial \delta} = \frac{-\frac{1}{2t}}{-C''(q_i) + \beta B''(\cdot)} > 0 \tag{12}$$

$$\frac{\partial q_1}{\partial t} = \frac{\frac{\delta}{2t^2}}{-C''(q_1) + \beta B''(\cdot)} > 0 \quad (13)$$

$$\frac{\partial q_1}{\partial \beta} = \frac{-B'(\cdot)}{-C''(q_1) + \beta B''(\cdot)} > 0 \quad (14)$$

$$\frac{\partial q_1}{\partial \Delta} = \frac{\frac{1}{4}}{-C''(q_1) + \beta B''(\cdot)} < 0 \quad (15)$$

The optimal quality level increase with the increase of reimbursement rate per service, which consists to our general knowledge; the quality level increase as the unmatched cost increases and as the differential level between hospitals decreases. This is due to the convexity of unmatched cost. And the more benevolent the provider is, the higher quality level it will pursue.

3.2 Location choice

At the stage 2 of the game, hospitals simultaneously choose their specialization, with the anticipation of their quality level, the first-order condition for an interior solution in the specialization game are given by:

$$\Delta = -\frac{\delta}{8t^2(\beta B'' - C'')} + \frac{(v+q-p)+\delta}{2t} > 0 \quad (16)$$

So, as the competition of quality level between hospitals, their choose the specialization with distinction, which can diminish the severity competition on one hand, and on the other hand, enjoy their reputation of proficient skill.

$$\frac{\partial \Delta}{\partial t} < 0 \quad (17)$$

It is known that if unmatched cost of patient to choose hospitals is lower, hospitals will have less incentive to pursue different specialization.

4. Conclusion

This paper reflects China's reality in hospitals' industry, where price are not feasible means of competition because it is set exogenous by central planner. And hospitals resort to other measures to increase market shares. In the absence of quality competition, we know that exogenous prices cause the hospitals to choose minimal differentiation. The paper gives a specialization-quality equilibrium and gets the conclusion that quality competition introduces a centrifugal force in the specialization game, which is conform to Brekke's conclusion. So, the tradeoff arises as to the strategic interaction for hospital managers between specialization and quality improve. Too severity of competing is not always good for patients in that unnecessary advanced treatment charge for a lot. And also it is a burden for small hospitals, and still induces close of some hospitals. Specially, pursue of high quality incur rapid growth of health expense, which a big problem most government face.

This paper is a trial in the discussion of the relationship between specialization and quality improve in health industry. In view of characteristic of hospital regulation and policy target, the result is significant in exhibiting the distinctive phenomenon in health care industry. While, for extension, the result need future induction in the aspects of making price exogenous but variable, and get implication for policy making in price setting. Besides, this paper did not distinguish types of patients, such as patients with high risk and lower risk. While, in reality, the model needs future consideration.

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