DISCUSSION PAPER SERIES

No. 9325

COMPETITION, EQUITY AND QUALITY IN HEALTHCARE

Maija Halonen-Akatwijuka and Carol Propper

PUBLIC POLICY

Centre for Economic Policy Research

www.cepr.org

Available online at: www.cepr.org/pubs/dps/DP9325.asp

ISSN 0265-8003

COMPETITION, EQUITY AND QUALITY IN HEALTHCARE

Maija Halonen-Akatwijuka, University of Bristol and CMPO
Carol Propper, University of Bristol, CMPO, Imperial College London and CEPR

Discussion Paper No. 9325
January 2013

Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 9325

January 2013

ABSTRACT

Competition, Equity and Quality in Healthcare*

In this paper we focus on the implications of consumer heterogeneity for whether competition will improve outcomes in health care markets. We show that competition generally favours the majority group as higher quality for the majority is an effective way to increase the quality signal and attract patients. A regulator who is concerned about equity may protect the minority group by not introducing competition. Alternatively, if the minority group is favoured by the providers under monopoly, competition can improve equity by forcing the providers to increase quality for the majority group.

JEL Classification: D63, H11, I11, I14 and L31
Keywords: competition, equity, hospitals and quality

Maija Halonen-Akatwijuka
Department of Economics
University of Bristol
8 Woodland Road
BRISTOL BS8 1TN

Email: maija.halonen@bristol.ac.uk

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=139114

Carol Propper
Department of Economics
University of Bristol
8 Woodland Road
Bristol BS8 1TN

Email: carol.propper@bristol.ac.uk

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=133851

*We thank Hans Gersbach, Bentley MacLeod and seminar participants at Birmingham, Essex, Helsinki, ESSET in Gerzensee, EARIE conference in Copenhagen, RES conference in Nottingham, and Universitat Pompeu Fabra for valuable comments. This paper was distributed earlier under the title "Allocation of Effort in Government Bureaucracies".

Submitted 21 January 2013

1 Introduction

The rising cost of healthcare means governments are constantly seeking ways to increase the productivity of the healthcare sector. In this aim, competition between healthcare suppliers is a reform model that has been pursued by several countries, including the UK, the Netherlands, Germany, Australia and Israel. In the US markets have long been used for the delivery of health care. However, widescale consolidation among hospitals has led to concerns about the functioning of these markets.[1] These developments raise questions as to whether competition is an appropriate way of improving outcomes in health care and in particular, because of the importance of quality in health care, whether competition will deliver high quality care (Federal Trade Commission and US Department of Justice (2004)).

In this paper we focus on the implications of consumer heterogeneity for whether competition will improve outcomes in health care markets. We examine the choice of a welfare maximizing regulator between monopoly provision and managed competition (competition where prices are regulated) under the following set of market features. Quality is not verifiable, providers are semi-altruistic, consumers are heterogeneous in their costs of treatment and are fully insured (so do not pay for their healthcare at point of use). These features are central to many health care markets. Unverifiable quality is important for the design of optimal financing arrangements where consumers are fully insured (for example, Chalkley and Malcomson (1998)).[2] It has long been recognized that providers of healthcare care about consumers as well as themselves (for example, Newhouse (1970); Ellis and McGuire (1986); Chalkley and Malcomson (1998); Rickman and McGuire (1999); Eggleston (2005); Kaarbøe and Siciliani (2011)). Consumer heterogeneity in treatment costs is central to concerns about the impact of regulated prices on equity (e.g. Ellis (1998)). And full insurance is common in many healthcare systems.

Our contribution is to consider providers whose private benefits differ

[1] Federal Trade Commission and US Department of Justice (2004) and Vogt and Town (2006).

[2] Grossman and Hart (1986) and Hart and Moore (1990) drew attention to the importance of unverifiability for choice of ownership.

across patients and to allow for equity concerns[3] of a market regulator who chooses whether or not to introduce competition. In our main model we assume that providers get lower private benefits from treating higher cost patients. For example, physicians might dislike treating patients who are high cost because they do not comply with their medical treatment (e.g. diabetics who do not attempt to lose weight, or alcoholics who do not stay in treatment programmes).[4] Under monopoly patients have no choice of provider. Under competition, the regulator pays a fixed price per patient and patients choose between competing providers on the basis of observed average quality (average due to the non-verifiable nature of types) and travel costs.[5]

We show that under no competition the regulator cannot induce the providers to provide more than the minimum effort (because quality cannot be contracted upon). The regulator will therefore pay only the minimum required to get the providers to participate. Thus provider effort, and so quality and its distribution across types, will depend only on the providers' own private benefits and costs of treatment. Providers will favour the low-cost more-rewarding type and the high-cost patient is underserved relative to their weight in the population. No competition is therefore low cost, but quality is low and the distribution of quality is inequitable.

Competition for patients will induce higher quality from providers in order to attract patients. However, importantly, it will not necessarily increase the level of quality for *both* types of patient. As patients choose between providers on the basis of average quality, competition for patients will induce more effort at the margin on the majority group because this increases the (average) quality signal more. The quality for the minority type may actually fall if this type is in a sufficiently small minority and substitutability of provider effort between the types is high.

In making the choice between monopoly and managed competition the regulator has to balance the increase in average quality and the change in

[3]Fehr and Schmidt (1999).

[4]Note that counter-example also exists: physicians may get high private benefits from treating technically complex and hence costly cases (an example being physicians who work in emergency rooms in inner city locations). We consider rewarding high-cost patients in an extension.

[5]The importance of distance in patient choice means spatial models of competition are standard in analysis of competition in health care markets. Brekke et al. (2010) and Gravelle and Sivey (2010) are recent examples.

the distribution of quality across types against the increased costs of transfers. When the majority group is rewarding for the healthcare providers, the regulator can choose to protect the minority from increased inequity by not introducing competition, as the rewarding type is favoured even more under competition than under monopoly. While a regulator who is not concerned about equity would introduce competition to increase average quality if the marginal tax cost is not too high.

However, when the providers find the minority group rewarding to treat (putting the majority at a disadvantage under monopoly), competition forces the providers to pay more attention to the majority type thus improving equity. Then the more concerned the regulator is about equity, the *more* likely he is to introduce competition. Thus we show that the effect of allowing for heterogeneity of patient type on the choice between monopoly and managed care is not simple. It does not mean that a regulator who cares about equity will necessarily be less likely to introduce competition than one who has no distributional concerns or vice versa.

The quality effect of competition is even richer when we take into account the possibility of corner solutions. If the low-cost type is very rewarding relative to the high-cost type, or if the cost difference is large, the provider does not exert any effort on the unrewarding type under monopoly. Competition coupled with a high enough price can restore incentives to exert effort for this type as long as it is not in a small minority. However, if the rewarding type is very low cost or in a significant majority, even a high price cannot motivate effort for the unrewarding type and corner solution remains under competition. Finally, competition can have a nonmonotonic effect on quality for the rewarding type if it is in a small minority.

Our paper contributes to a number of literatures. There are a small number of papers that examine the choice between monopoly and managed competition (competition with regulated prices) in a tax funded health care system. None of these papers consider consumer heterogeneity. Gravelle (1999) analyzes the role of prospective payments for quality provision under different market structures. His focus is on how market structure evolves. Beitia (2003) analyzes the choice of competition when the regulator does not know the production costs of the hospitals (amongst other cases). Monopoly is preferred when it is better for the low-cost hospital to cover the whole market. Halonen and Propper (2008) analyze the choice of a self-interested politician between competition and monopoly. They show that the politician is more likely to introduce competition for services that have considerable political support.[6]

Most relevant are Brekke et al. (2008) and (2011) who examine the relationship between competition and waiting times and between competition and quality respectively in a Salop type setting. Brekke et al. (2011) extends existing models of competition and quality by including semi-altruistic healthcare providers and heterogeneous patients. Like the present paper, they find that altruism matters and that competition may not be beneficial. However, they do not examine the case where the private benefits of provision differ across patients. Given the importance of semi-altruistic providers and patient heterogeneity in healthcare, it seems important to allow for the fact that providers private benefits may depend on patient type. Indeed this very concern lies at the heart of the argument that monopoly welfare state providers favour richer individuals at the expense of their poorer counterparts (Le Grand (2003)).

More broadly, the issue of motivated (or altruistic) agents in the delivery of public services is increasingly recognized as important. For example, Francois (2000) argues that agent motivation justifies the choice of non-profit firms in public service delivery. Besley and Ghatak (2005) show that matching between mission orientated firms and motivated agents reduces the need for high powered contracts. Delfgaauw and Dur (2007, 2008) show that in an equilibrium both non-profit providers and for profit providers can exist but that they will differ in altruism and productivity. Our paper thus contributes to the literature on the impact of altruism on the optimal organization of public services.

The rest of the paper is organized as follows. Section 2 presents our model. The first-best solution is obtained in Section 3. Sections 4 and 5 analyze no competition and competition respectively while Section 6 derives the optimal institution. Various extensions are discussed in Section 7. Section 8 concludes.

2 The model

There are two hospitals each run by a manager M_i, $i = 1, 2$. There are two types of patients, A and B. Proportion γ_A of the population is of type A and proportion $\gamma_B = (1 - \gamma_A)$ is of type B.

[6]Gersbach and Halonen-Akatwijuka (2012) consider consumer heterogeneity but compare different competition regimes including also private suppliers.

The value of the hospital's service to the patients depends on the manager's effort, e_i^j $i = 1, 2,$ $j = A, B$. The value is:

$$\begin{aligned} v_i^A &= e_i^A \text{ for type A and} \\ v_i^B &= e_i^B \text{ for type B.} \end{aligned}$$

We assume that the quality of the service is not verifiable. Therefore, contracts on quality cannot be enforced by the courts. However, an average quality signal $v_i = \gamma_A v_i^A + \gamma_B v_i^B$ is observable to the patients and therefore competition can provide incentives.

Effort cost to the manager is $C\left(e_i^A, e_i^B\right) = \frac{1}{2}\alpha_A \left(e_i^A\right)^2 + \frac{1}{2}\alpha_B \left(e_i^B\right)^2 + \delta e_i^A e_i^B$ where $\alpha_A \alpha_B > \delta^2$. Type A is costlier to treat than type B, $\alpha_A > \alpha_B$. We assume that the type is unverifiable.

M_i is assumed to be risk neutral. In addition to the monetary wage, w_i, she receives a private benefit from the value of the service:

$$B\left(v\left(e_i^A\right), v\left(e_i^B\right)\right) = \mu_A e_i^A + \mu_B e_i^B$$

M_i is a semi-altruistic professional who enjoys her work but may put different weights on the types from the population proportions. We assume that M_i gets a higher private benefit from treating the low-cost patients, i.e. $\mu_B \geq \mu_A$.[7] We also assume that type B is not too rewarding relative to A to ensure an interior solution.[8]

Assumption 1. $\mu_B/\mu_A < \alpha_B/\delta$.

The outside wage for M_i is zero and therefore she is willing to participate for any nonnegative utility. M_i's utility is:

$$U_i = w_i + B\left(v\left(e_i^A\right), v\left(e_i^B\right)\right) - C\left(e_i^A, e_i^B\right)$$

We assume a Hotelling model where the two hospitals are located at the extremes of the unit interval $[0, 1]$. Hospital 1 is located at 0 and hospital 2 at 1. The patients of each type are uniformly distributed with density one on the unit interval. A patient of type j located at $0 \leq x \leq 1$ receives utility

[7] In Section 7.2 we discuss the case where the high-cost type is more rewarding.

[8] In Section 7.1 we explore the possibility of a corner solution.

$v_1^j - tx$ if he is supplied by 1 and utility $v_2^j - t(1-x)$ if he is supplied by 2, where t is the transportation cost. Each hospital has a capacity of one.

Regulator R chooses whether to introduce competition between the hospitals. If there is *no competition,* each hospital gets the closest half of patients and the hospitals get their budget directly from R.

With *competition* patients choose between competing hospitals but pay zero at point of service. The patient's choice depends on the average quality $v_i = \gamma v_i^A + (1-\gamma) v_i^B$ and takes into account the transportation costs to the hospital. We assume hospitals cannot select patients (we are essentially considering a universal service in which all the patients who are referred for hospital treatment are served). The hospital's market share depends on the relative value of the service and on the transportation costs. The Hotelling model gives the following demand function:

$$q_i(v_i, v_j) = \frac{v_i - v_j + t}{2t}.$$

Under competition the hospital is paid p per patient. R chooses p. The hospital can keep any surplus generated and choose the manager's wage.

R designs the organization to maximize the benefit from the service minus the cost of transfers to the hospitals, $D(T)$ where $D'(T) > 0$ and $D''(T) > 0$. Transfer costs are paid for by taxation. The benefit equals the value of the service to the patients adjusted by R's concern for equity, measured by parameter $\lambda \geq 0$. R's utility is:

$$\gamma_A v^A + \gamma_B v^B - \lambda \left| v^B - v^A \right| - D(T) \tag{1}$$

Since we have a symmetric model, the hospitals' service levels and market shares are equal. We therefore have dropped the subscripts from the notation.

3 First best

In this section we derive the first-best solution. It is clear that the first-best effort levels are equal for each type of patient across hospitals $\left(e^j \equiv e_1^j = e_2^j \text{ for } j = A, B\right)$ and market shares are equal to minimize transportation costs. The first-best efforts maximize the social surplus

$$\underset{\{w,e^A,e^B\}}{Max}\ \gamma_A v^A + \gamma_B v^B - \lambda \left| v^B - v^A \right| + 2B\left(v^A, v^B\right) - 2C\left(e^A, e^B\right) - D\left(2w\right)$$

subject to participation constraint

$$w + B\left(v^A, v^B\right) - C\left(e^A, e^B\right) \geq 0 \tag{2}$$

The first-best efforts, e^{A*} and e^{B*}, are given by[9]:

$$\gamma_A + \lambda + \mu_A - \alpha_A e^{A*} - \delta e^{B*} - D'\left(C\left(e^{A*}, e^{B*}\right) - B\left(e^{A*}, e^{B*}\right)\right) = 0 \tag{3}$$

$$\gamma_B - \lambda + \mu_B - \alpha_B e^{B*} - \delta e^{A*} - D'\left(C\left(e^{A*}, e^{B*}\right) - B\left(e^{A*}, e^{B*}\right)\right) = 0 \tag{4}$$

The first-best efforts equate the marginal benefit of higher quality service (adjusted by the regulator's concern for equity) and higher private benefits for M_i to the marginal effort cost and marginal cost of compensating M_i to participate. Note that the social surplus differs from R's objective function as it includes the managers' private benefits and effort costs.

4 No competition

Without competition there is nothing contractible on which incentives can be based. Both effort and the value of the service are unverifiable. Therefore an ex ante contract cannot provide incentives. Neither can ex post bargaining since efforts are sunk and M_i can be fired by R at no cost. Accordingly, only the private benefits provide incentives under no competition.

The manager's problem is to:

$$\underset{\{e_i^A,e_i^B\}}{Max}\ w_i + B\left(v\left(e_i^A\right), v\left(e_i^B\right)\right) - C\left(e_i^A, e_i^B\right)$$

The first-order conditions are:

[9]We assume that an interior solution where $e^{A*} > 0$ and $e^{B*} > 0$ exists. Further, $(\mu_A + \mu_B)$ is not so high that M_i does not need to be compensated by a wage to participate. We also take into account that $e^{B*} > e^{A*}$ given $\mu_B \geq \mu_A$ and $\alpha_B < \alpha_A$.

$$\mu_A - \alpha_A e_i^A - \delta e_i^B = 0 \quad (5)$$

$$\mu_B - \alpha_B e_i^B - \delta e_i^A = 0 \quad (6)$$

It is straightforward to show that the optimal efforts are given by:

$$e^A = \frac{\alpha_B \mu_A - \delta \mu_B}{\alpha_A \alpha_B - \delta^2} \quad (7)$$

$$e^B = \frac{\alpha_A \mu_B - \delta \mu_A}{\alpha_A \alpha_B - \delta^2} \quad (8)$$

We drop the subscripts from the notation since the solution is symmetric.

Higher private benefit for type B, μ_B, increases M$_i$'s effort for type B. If there are positive externalities between the tasks $(\delta < 0)$, this reduces the marginal cost of type A and therefore also effort for type A is increased. Positive externalities can arise e.g. from learning spill-overs between the tasks. However, when there are negative externalities between the tasks $(\delta > 0)$, the marginal cost of treating type A is increased. Therefore effort for type A is lower. Examples of negative externalities include time constraints and limited attention.

Equations (7) and (8) show that M$_i$ exerts more effort on the rewarding type B.[10] Therefore type B gets a higher quality service than type A under no competition.

R can only pay a fixed wage to M$_i$. Since a fixed wage does not provide any incentives, there is no reason for R to pay a positive wage. R sets $w_i = 0$ and this also satisfies M$_i$'s participation constraint.

R's utility is:

$$U^N = \gamma_A e^{A,N} + \gamma_B e^{B,N} - \lambda \left(e^{B,N} - e^{A,N}\right) - D(0)$$

where superscript N refers to no competition.

5 Competition

Under competition M$_i$ chooses efforts and wages to maximize her utility subject to the constraint that the hospital cannot make losses.

[10] $e^A < e^B \Leftrightarrow (\alpha_B + \delta)\,\mu_A < (\alpha_A + \delta)\,\mu_B$ which is satisfied since $\mu_A < \mu_B$ and $\alpha_B < \alpha_A$.

$$\underset{\{w_i, e_i^A, e_i^B\}}{Max} \; w_i + B\left(v\left(e_i^A\right), v\left(e_i^B\right)\right) - C\left(e_i^A, e_i^B\right)$$

$$s.t. \; pq_i\left(v_i, v_j\right) - w_i \geq 0$$

The horizontal differentiation model gives the following demand function:

$$q_i\left(v_i, v_j\right) = \frac{v_i - v_j + t}{2t} \tag{9}$$

where the average value of the service is:

$$v_i = \gamma_A v_i^A + \gamma_B v_i^B.$$

M_i is in effect a residual claimant and therefore the no-loss constraint is always binding. We can write M_i's problem as:

$$\underset{\{e_i^A, e_i^B\}}{Max} \; p\frac{v_i - v_j + t}{2t} + B\left(v\left(e_i^A\right), v\left(e_i^B\right)\right) - C\left(e_i^A, e_i^B\right) \tag{10}$$

The first-order conditions are:

$$\gamma_A \frac{p}{2t} + \mu_A - \alpha_A e_i^A - \delta e_i^B = 0 \tag{11}$$

$$\gamma_B \frac{p}{2t} + \mu_B - \alpha_B e_i^B - \delta e_i^A = 0 \tag{12}$$

Comparing these with the no-competition case (equations (5) and (6)), we see that the only difference is the first term. With competition, higher effort increases the market share and so the revenues, enabling wages to be increased. Competition thus introduces a monetary reward in addition to the private benefits. The monetary reward for each type depends on the proportion of that type in the population. Exerting effort on the majority type is an effective way to increase the average value signal. High average value attracts patients of both types to the hospital, even though the hospital may not provide high value service for both types.

Optimal efforts are given by[11]:

$$e^A = \frac{(\alpha_B\gamma_A - \delta\gamma_B)\,\frac{p}{2t} + \alpha_B\mu_A - \delta\mu_B}{\alpha_A\alpha_B - \delta^2} \tag{13}$$

$$e^B = \frac{(\alpha_A\gamma_B - \delta\gamma_A)\,\frac{p}{2t} + \alpha_A\mu_B - \delta\mu_A}{\alpha_A\alpha_B - \delta^2} \tag{14}$$

Our first observation is that competition with $p = 0$ is equivalent to no competition (compare (13) and (14) to (7) and (8)). Therefore, differentiating the efforts with respect to p is helpful in finding the effect of competition on the value of service. Interestingly, the efforts are not always increasing in p, as Proposition 1 shows.

Proposition 1 *(i)* $\frac{\partial v^A}{\partial p} > 0$ *and* $\frac{\partial v^B}{\partial p} > 0$ *if* $\delta \leq 0$ *or* $\delta > 0$ *and* $\frac{\delta}{(\alpha_B+\delta)} < \gamma_A < \frac{\alpha_A}{(\alpha_A+\delta)}$.

(ii) $\frac{\partial v^i}{\partial p} > 0$ *and* $\frac{\partial v^j}{\partial p} < 0$ *if and only if* $\delta > 0$ *and* $\gamma_j < \frac{\delta}{(\alpha_i+\delta)}$.

(iii) $\gamma_A \frac{\partial v^A}{\partial p} + \gamma_B \frac{\partial v^B}{\partial p} > 0$.

Proposition 1(*i*) is the case where competition increases the value of the service for both types of patients. This is perhaps the case that most policy makers have in mind. However, Proposition 1 shows that this result is far from general. If there are positive externalities between the types ($\delta \leq 0$), then the higher price increases service quality for both types. But with negative externalities competition tends to favour the majority at the expense of the minority because a good quality service for the majority is an effective way to increase the average quality signal. If neither type is in significant majority, then the service quality increases for both types as shown by (*i*). However, also the cost factors play a role. For example, the more cost-effective B is (the lower α_B), the larger the proportion of the unrewarding type, γ_A, has to be to motivate M_i to increase effort for both types. Note also that the stronger the negative externality (larger δ), the tighter the parameter restrictions are for this case.

[11] Here we abstract from possible corner solutions where $e^A = 0$ for large enough p when $\alpha_B\gamma_A - \delta\gamma_B < 0$ or $e^B = 0$ for large enough p when $\alpha_A\gamma_B - \delta\gamma_A < 0$. Equity concerned R would not choose so high a p that it drives the value of the service for one type to zero.

In Proposition 1(ii) one type is in significant majority and higher p favours the majority at the expense of the minority. Note that in this case competition can, interestingly, make the service more equitable. This is the case when type A is in majority. Under no competition M_i favours the rewarding B while type A gets a lower quality service. But because type A is in significant majority, competition forces M_i to increase her effort on type A at the expense of type B and results in a more equitable service. Alternatively, if B is in majority, competition further increases the difference in the service levels resulting in a more inequitable service. Note, that as per (iii), the average quality is always increasing in p.

Transfers to the hospitals under competition are equal to the hospitals' revenues.

$$T = \sum_{i=1}^{2} pq_i = p\sum_{i=1}^{2} q_i = p$$

R's utility under competition depends on the price he chooses:

$$U^C = \gamma_A e^{A,C}(p) + \gamma_B e^{B,C}(p) - \lambda\left(e^{B,C}(p) - e^{A,C}(p)\right) - D(p)$$

where superscript C refers to competition.

6 Optimal institution

In this section we examine when it is optimal for R to introduce competition. Since competition with $p = 0$ is equivalent to no competition, the comparison of these institutions boils down to the question if it is optimal for R to choose $p^* > 0$ or $p^* = 0$. If $p^* > 0$, it must be that competition dominates no competition. On the other hand, if $p^* = 0$, that is in effect choosing no competition.

R maximizes the benefit from the total value of the service adjusted by his concern for equity minus the cost of transfers to the hospitals.

$$\underset{\{p\}}{Max}\ \ \gamma_A e^A(p) + \gamma_B e^B(p) - \lambda\left|e^B(p) - e^A(p)\right| - D(p) \tag{15}$$

The Kuhn-Tucker condition is given by[12]

$$\left[(\gamma_A + \lambda)\frac{\partial e^A}{\partial p} + (\gamma_B - \lambda)\frac{\partial e^B}{\partial p}\right] - D'(p) \leq 0 \tag{16}$$

A higher price increases the average value of the service as well as the transfers to the hospitals. Furthermore, a higher price affects the equity of the service levels. Inequity is clearly increased in the case where the higher price increases the effort for type B at the expense of type A. But inequity can increase even when both efforts increase. It is straightforward to show that:

$$\frac{\partial e^B}{\partial p} - \frac{\partial e^A}{\partial p} > 0 \text{ if and only if } \gamma_A < \frac{\alpha_A + \delta}{\alpha_A + \alpha_B + 2\delta} \equiv \widetilde{\gamma}_A \tag{17}$$

Note that $\widetilde{\gamma}_A > 1/2$. Therefore, competition increases inequity unless type A is in a large enough majority.

It is not optimal for R to introduce competition if R's marginal utility evaluated at $p = 0$ is non-positive:

$$(\gamma_A + \lambda)\frac{\partial e^A}{\partial p} + (\gamma_B - \lambda)\frac{\partial e^B}{\partial p} - D'(0) \leq 0. \tag{18}$$

Proposition 2 explores how R's decision depends on our key parameters, the share of the unrewarding type in the population, γ_A, R's concern for equity, λ, and the marginal cost of raising taxes, $D'(0)$.

Proposition 2 *Assume* $D'(0) < 1/2t\,(\alpha_A + \alpha_B + 2\delta)$.

(*i*) *For* $\lambda \geq \overline{\lambda}$ *no competition is optimal if and only if* $\gamma_A \in [0, \widehat{\gamma}_A]$ *where* $\widehat{\gamma}_A < \widetilde{\gamma}_A$, $\frac{\partial \widehat{\gamma}_A}{\partial D'(0)} > 0$ *and* $\frac{\partial \widehat{\gamma}_A}{\partial \lambda} > 0$.

(*ii*) *For* $\lambda \in \left[\underline{\lambda}, \overline{\lambda}\right)$ *no competition is optimal if and only if* $\gamma_A \in \left[\underline{\gamma}_A, \overline{\gamma}_A\right]$ *where* $0 < \underline{\gamma}_A < \overline{\gamma}_A < \widehat{\gamma}_A$, $\frac{\partial \underline{\gamma}_A}{\partial D'(0)} < 0$, $\frac{\partial \underline{\gamma}_A}{\partial \lambda} < 0$ $\frac{\partial \overline{\gamma}_A}{\partial D'(0)} > 0$, $\frac{\partial \overline{\gamma}_A}{\partial \lambda} > 0$ *and* $\overline{\gamma}_A > 1/2$ *for* $(\alpha_A - \alpha_B)$ *large.*

(*iii*) *For* $\lambda < \underline{\lambda}$ *competition is optimal for all* γ_A.

Proposition 2 is illustrated by Figure 1 which has the proportion of the unrewarding type A in the horizontal axis and the marginal benefits and

[12] The other Kuhn-Tucker conditions are given by $p \geq 0$ and $\left[(\gamma_A + \lambda)\frac{\partial e^A}{\partial p} + (\gamma_B - \lambda)\frac{\partial e^B}{\partial p} - D'(p)\right] p = 0$.

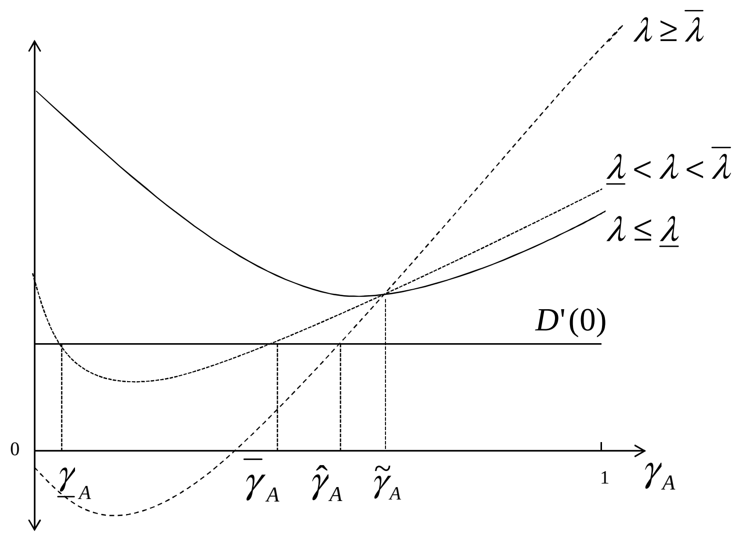

Figure 1

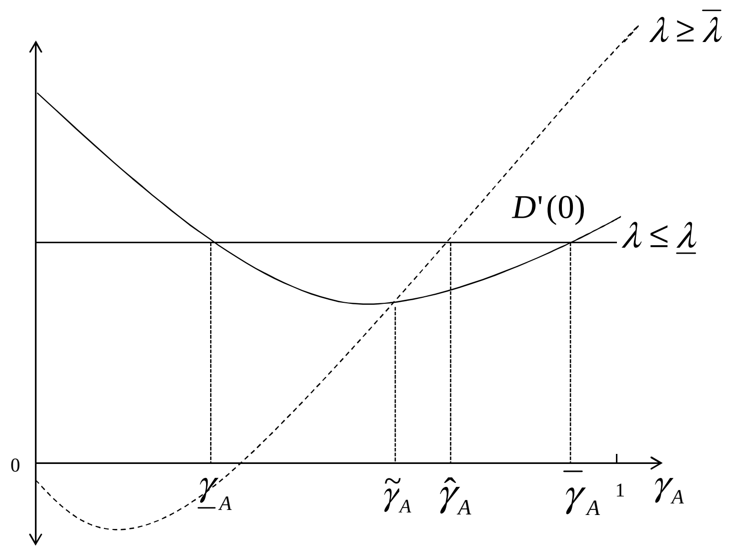

Figure 2

costs of competition for the regulator on the vertical axis. The inequity adjusted marginal benefit of competition[13] is U-shaped and also depends on λ, as illustrated by the three curves. The more R is concerned about equity (the higher λ), the lower is the marginal benefit for $\gamma_A < \widetilde{\gamma}_A$, the parameter range where competition increases inequity, and the higher is the marginal benefit for $\gamma_A > \widetilde{\gamma}_A$, the parameter range where competition improves equity. The solid line denotes $\lambda = 0$ and the broken line $\lambda \geq \overline{\lambda}$. No competition is optimal if the inequity adjusted marginal benefit falls below the marginal tax cost of competition, $D'(0)$, denoted by the horizontal line.

When R is very concerned about equity $\left(\lambda \geq \overline{\lambda}\right)$, the first cutting point of the U-shaped marginal benefit curve with the marginal cost line $D'(0)$ occurs for $\gamma_A < 0$, implying that the marginal benefit of competition falls short of its marginal cost for all $\gamma_A \in [0, \widehat{\gamma}_A]$. This illustrates Proposition 2 (i). If R is very concerned about equity, he will not introduce competition when γ_A is small enough in order to protect type A. Under no competition type A receives a lower quality service than the rewarding type B. For $\gamma_A < \delta/(\alpha_B + \delta)$ competition further favours B at the expense of A. If $\delta/(\alpha_B + \delta) < \gamma_A < \widehat{\gamma}_A$ competition increases the service levels for *both* types but v^B increases more than v^A increasing inequity. R's concern for equity overrides his gain from the increase in quality and therefore he will not introduce competition. However, for $\widehat{\gamma}_A < \gamma_A < \widetilde{\gamma}_A$, the increase in inequity is so small that even if R is greatly concerned about equity, he introduces competition to benefit from higher service levels for both types. Finally, when $\gamma_A > \widetilde{\gamma}_A$ competition improves equity in addition to average quality, and R thus finds it optimal to introduce competition.

If R is moderately concerned about equity (Proposition 2(ii) and the dotted line in Figure 1), he will not withhold the benefit of competition from the majority type B when A is a small minority $\left(\gamma_A < \underline{\gamma}_A\right)$, despite the fact that A would suffer from competition. But when the proportion of type A is large enough to affect the average value $\left(\gamma_A \geq \underline{\gamma}_A\right)$ yet small enough so that inequity would be increased $(\gamma_A \leq \overline{\gamma}_A)$, R will not introduce competition.

Finally, when R's concern for equity is low (Proposition 2(iii) and the solid line in Figure 1), he will introduce competition for all values of γ_A. This is because Proposition 2 assumes that the marginal tax cost is relatively low or competition between the hospitals is strong enough (low t) so that

[13] The first two terms in equation (18).

$D'(0) < 1/2t(\alpha_A + \alpha_B + 2\delta)$.

Proposition 2 also shows that A does not have to be in minority for R to protect him from competition. When $(\alpha_A - \alpha_B)$ is large, $\widehat{\gamma}_A > \overline{\gamma}_A > 1/2$. Therefore, even when A is in moderate majority, competition increases inequity because B is so low-cost. R then protects the high-cost A by not introducing competition.

Proposition 2 and Figure 1 show that no competition is the more likely, the more concerned R is about equity. The parameter range for which no competition in optimal is increasing in λ. Furthermore, R is less likely to introduce competition, the higher is the marginal tax cost of competition, $D'(0)$.

However, competition can also improve equity (when $\gamma_A > \widetilde{\gamma}_A$). This effect plays a major role in Proposition 3, which considers the case where increasing taxes is quite costly.

Proposition 3 *Assume* $1/2t(\alpha_A + \alpha_B + 2\delta) < D'(0) < \alpha_B/2t\left(\alpha_A\alpha_B - \delta^2\right)$.

(i) For $\lambda \geq \widehat{\lambda}$ *no competition is optimal if and only if* $\gamma_A \in [0, \widehat{\gamma}_A]$ *where* $\widehat{\gamma}_A > \widetilde{\gamma}_A$, $\frac{\partial \widehat{\gamma}_A}{\partial D'(0)} > 0$ *and* $\frac{\partial \widehat{\gamma}_A}{\partial \lambda} < 0$.

(ii) For $\lambda < \widehat{\lambda}$ *no competition is optimal if and only if* $\gamma_A \in \left[\underline{\gamma}_A, \overline{\gamma}_A\right]$ *where* $0 < \underline{\gamma}_A < \widehat{\gamma}_A < \overline{\gamma}_A$, $\frac{\partial \underline{\gamma}_A}{\partial D'(0)} < 0$, $\frac{\partial \underline{\gamma}_A}{\partial \lambda} < 0$, $\frac{\partial \overline{\gamma}_A}{\partial D'(0)} > 0$ *and* $\frac{\partial \overline{\gamma}_A}{\partial \lambda} < 0$.

Proposition 3 is illustrated in Figure 2. The main difference to Proposition 2 is that now, the more concerned R is about equity, the *more* likely he is to introduce competition when A is in majority ($\partial\widehat{\gamma}_A/\partial\lambda < 0$ and $\partial\overline{\gamma}_A/\partial\lambda < 0$). Competition forces M_i to pay more attention to the majority type A and because R is highly concerned about equity he is willing to pay the high tax cost of competition, $D'(0)$.

To summarize, our results depend on three key parameters: the proportion of the unrewarding types in the population, γ_A, the regulator's concern for equity, λ, and the marginal tax cost of competition, $D'(0)$. If the unrewarding type is in a minority, the regulator may choose to protect them from increased inequity by not introducing competition. However, if the regulator is not concerned about equity, he will introduce competition unless the marginal tax cost is high. If the unrewarding type is in a majority, then competition shifts the balance of efforts towards the underserved majority improving equity. Then competition is beneficial particularly for the equity concerned regulator who will introduce competition unless the marginal tax cost is too high.

7 Extensions

7.1 Corner solution in efforts

We will now consider the possibility of a corner solution in efforts. M_i chooses to exert effort only on type B under no competition if it is rewarding enough compared to type A and there are negative externalities ($\delta > 0$ and $\mu_B/\mu_A \geq \alpha_B/\delta$, violating Assumption 1). Alternatively, if B is easy ($\alpha_B < \delta$), then M_i does not exert any effort on type A even if the types are equally rewarding because B is so low-cost. This corner solution is the more likely, the stronger are the negative externalities (larger δ).

Allowing for the possibility of a corner solution opens up further richness in the quality response to competition. In some cases it is possible to move away from the corner solution by paying the hospital a high enough p.

Proposition 4 *Assume* $\mu_B/\mu_A \geq \alpha_B/\delta$ *and* $\delta > 0$.

(*i*) $\frac{\partial v^A}{\partial p} = 0$ *and* $\frac{\partial v^B}{\partial p} > 0$ *for any* $p \leq \underline{p} \equiv 2t(\delta\mu_B - \alpha_B\mu_A)/\left(\alpha_B\gamma_A - \delta\gamma_B\right)$, *and* $\frac{\partial v^A}{\partial p} > 0$ *and* $\frac{\partial v^B}{\partial p} > 0$ *for any* $p > \underline{p}$ *if and only if* $\frac{\delta}{(\alpha_B+\delta)} < \gamma_A < \frac{\alpha_A}{(\alpha_A+\delta)}$.

(*ii*) $\frac{\partial v^A}{\partial p} = 0$ *and* $\frac{\partial v^B}{\partial p} > 0$ *for any* $p > 0$ *if and only if* $\gamma_A < \frac{\delta}{(\alpha_B+\delta)}$.

(*iii*) $\frac{\partial v^A}{\partial p} = 0$ *and* $\frac{\partial v^B}{\partial p} > 0$ *for any* $p < \underline{p}$,
and $\frac{\partial v^A}{\partial p} > 0$ *and* $\frac{\partial v^B}{\partial p} < 0$ *for any* $p \geq \underline{p}$ *if and only if* $\gamma_B < \frac{\delta}{(\alpha_A+\delta)}$.

The different cases in Proposition 4 depend on the proportion of the unrewarding type. In Proposition 4(*i*) neither type is in significant majority and therefore as long as the price is high enough, both efforts increase under competition. However, if the hospital is paid a relatively low price, M_i continues to exert zero effort on type A even under competition.

In (*ii*) B is easy or in significant majority and even a high p cannot motivate effort for type A because it is so cheap to increase average value signal by focusing effort on type B.[14] Therefore, a corner solution remains for any $p > 0$. In this case unbundling the service for the two types would be needed to guarantee positive effort level for type A. However, we have assumed that the types are unverifiable and therefore unbundling is not possible.

[14] When B is easy $\delta/\left(\alpha_B + \delta\right) > 1/2$ and $\gamma_A < \delta/\left(\alpha_B + \delta\right)$ can be satisfied even when $\gamma_A > 1/2$.

In *(iii)* A is in significant majority and a high enough price can motivate effort for type A. Interestingly, this results in a nonmonotonic effect on effort for type B. For prices that are too low to motivate M_i from the corner solution, a higher price does motivate more effort for type B. But when p is high enough to obtain an interior solution, increasing p further will lower the effort exerted for the minority type B resulting in a nonmonotonic effect. In this case, competition leads to a more equitable service as long as the hospital is paid a high enough price. In sum, the quality effect of competition is then even richer when we take into account the possibility of corner solution as the effects depend also on the level of price chosen.

7.2 Rewarding high-cost patients

We have analyzed the case where M_i finds the low-cost patients more rewarding to treat. Alternatively, the high-cost patients could be more rewarding, for example, if treating them reaps significant professional kudos. Our analysis is broadly a mirror image of this case. Now type A could get a better service under no competition and R may need to protect type B by not introducing competition. However, it is also possible that the unrewarding type B gets a better service under competition if the cost difference is large enough. [15] In this case it is the rewarding type A that may have to be protected from competition.

7.3 Fixed costs

We have assumed that the hospitals have no fixed costs. If we introduce a fixed cost, f, in the analysis, then competition becomes less costly for R to introduce. Under no competition R covers f by a direct transfer to the hospital resulting in the cost of $D(2f)$. Under competition the hospital has to cover f by winning enough patients. Therefore, competition increases transfers to the hospitals only by $D(p^*) - D(2f)$. R is then more likely to introduce competition, the higher is the fixed cost. However, this does not imply that competition will always dominate for large f. When R is concerned enough of equity, the marginal benefit of competition is negative

[15] It is even possible to have the second corner solution where M_i exerts effort only on the unrewarding type B. This is the case if B is easy and A is only moderately more rewarding than B. $e^A = 0$ if and only if $\mu_A/\mu_B \leq \delta/\alpha_B$ where $\delta/\alpha_B > 1$ when B is easy. Therefore $e^A = 0$ when A is moderately more rewarding than B.

for some values of γ_A and R would not introduce competition however low the cost is.[16]

In Beitia (2003)), fixed costs have the opposite effect and it is optimal to introduce competition when fixed costs are low. Our results differ because we take the existing hospital network as given and compare competition between the hospitals to no competition where each hospital has a monopoly in their local market. In both structures the fixed costs equal $2f$. In Beitia (2003) only one fixed cost is paid under monopoly.

8 Conclusions

There is considerable debate over whether competition increases quality in health care. We consider a setting in which providers are motivated and there is consumer heterogeneity in the private benefits and costs of treatment. We analyze the choice of a welfare maximizing regulator over whether or not to introduce competition. We show that in a world where providers favour a minority group competition forces the providers to shift the balance of their efforts towards the underserved majority, in addition to providing a higher average quality. Then competition is a good reform model as long as the marginal tax cost of competition is not too high. Alternatively, in a world where providers find the minority group unrewarding, competition further exacerbates the inequity in service levels and can even reduce quality for the minority group. Then a regulator who is concerned about equity chooses to protect the minority group by not introducing competition. Finally, a regulator who is not concerned about equity will introduce competition as long as the benefit of higher average quality outweighs the marginal tax cost of competition.

This can be compared to the case where we have motivated agents but no consumer heterogeneity. In this case, competition increases quality and the regulator will adopt competition if the benefits from increasing quality outweigh the extra tax cost (Halonen and Propper (2008)). Thus we have shown that introducing consumer heterogeneity where agents are motivated makes the case for competition more nuanced, even where there is no patient selection by providers.

[16] See the broken line in Figure 1.

A Appendix

Proof of Proposition 1.

It follows from (13) and (14) that:

$$\frac{\partial e^A}{\partial p} = \frac{(\alpha_B \gamma_A - \delta \gamma_B)}{2t\left(\alpha_A \alpha_B - \delta^2\right)} \tag{19}$$

$$\frac{\partial e^B}{\partial p} = \frac{(\alpha_A \gamma_B - \delta \gamma_A)}{2t\left(\alpha_A \alpha_B - \delta^2\right)} \tag{20}$$

Proof of (i) and (ii) is then straight-forward.

(iii) Average quality is given by:

$$\overline{e} = \gamma_A e^A + \gamma_B e^B \tag{21}$$

Differentiating (21) with respect to p we obtain:

$$\frac{\partial \overline{e}}{\partial p} = \gamma_A \frac{\partial e^A}{\partial p} + \gamma_B \frac{\partial e^B}{\partial p} = \frac{\alpha_B \gamma_A^2 - 2\delta \gamma_A \gamma_B + \alpha_A \gamma_B^2}{2t\left(\alpha_A \alpha_B - \delta^2\right)} \tag{22}$$

To verify that $\partial \overline{e}/\partial p > 0$, we find the value of γ_A that minimizes $\partial \overline{e}/\partial p$.

$$\frac{\partial^2 \overline{e}}{\partial p \partial \gamma_A} = \frac{2\left(\alpha_A + \alpha_B + 2\delta\right)\gamma_A - 2\left(\alpha_A + \delta\right)}{2t\left(\alpha_A \alpha_B - \delta^2\right)} = 0$$

$\partial \overline{e}/\partial p$ is minimal for

$$\gamma_A = \frac{(\alpha_A + \delta)}{(\alpha_A + \alpha_B + 2\delta)} \tag{23}$$

To verify that $\partial \overline{e}/\partial p > 0$ even in its minimal point, we insert (23) in (22) :

$$\frac{\partial \overline{e}}{\partial p} \stackrel{s}{=} \alpha_B \gamma_A^2 - 2\delta \gamma_A \gamma_B + \alpha_A \gamma_B^2 = \frac{\left(\alpha_A \alpha_B - \delta^2\right)}{(\alpha_A + \alpha_B + 2\delta)} > 0$$

Therefore $\partial \overline{e}/\partial p > 0$ for all $\gamma_A \in [0, 1]$. Q.E.D.

Proof of Proposition 2.

Denote the inequity adjusted marginal benefit of competition by

$$\Lambda\left(\gamma_A\right) \equiv \left(\gamma_A + \lambda\right) \frac{\partial e^A}{\partial p} + \left(\gamma_B - \lambda\right) \frac{\partial e^B}{\partial p}. \tag{24}$$

No competition is optimal if and only if $\Lambda(\gamma_A) \leq D'(0)$.

We will first examine the properties of $\Lambda(\gamma_A)$ to construct Figure 1. Inserting (19) and (20) in (24) we obtain:

$$\begin{aligned}\Lambda(\gamma_A) &= \frac{\gamma_A(\alpha_B\gamma_A - \delta\gamma_B)}{(\alpha_A\alpha_B - \delta^2)\,2t} + \frac{\gamma_B(\alpha_A\gamma_B - \delta\gamma_A)}{(\alpha_A\alpha_B - \delta^2)\,2t} + \frac{\lambda(\alpha_B\gamma_A - \delta\gamma_B - \alpha_A\gamma_B + \delta\gamma_A)}{(\alpha_A\alpha_B - \delta^2)\,2t} \\ &= \frac{(\alpha_A + \alpha_B + 2\delta)(\gamma_A)^2 + \gamma_A[\lambda(\alpha_A + \alpha_B + 2\delta) - 2(\alpha_A + \delta)] + [(1-\lambda)\alpha_A - \lambda\delta]}{(\alpha_A\alpha_B - \delta^2)\,2t}\end{aligned} \tag{25}$$

Evaluating $\Lambda(\gamma_A)$ for the extreme values of γ_A we obtain:

$$\Lambda(0) = \frac{(1-\lambda)\alpha_A - \delta\lambda}{(\alpha_A\alpha_B - \delta^2)\,2t} \leq 0 \;\Leftrightarrow\; \lambda \geq \frac{\alpha_A}{(\alpha_A + \delta)} \tag{26}$$

$$\Lambda(1) = \frac{(1+\lambda)\alpha_B + \lambda\delta}{(\alpha_A\alpha_B - \delta^2)\,2t} > 0 \tag{27}$$

Next we differentiate $\Lambda(\gamma_A)$ with respect to γ_A.

$$\frac{\partial\Lambda}{\partial\gamma_A} = \frac{2(\alpha_A + \alpha_B + 2\delta)\gamma_A + [\lambda(\alpha_A + \alpha_B + 2\delta) - 2(\alpha_A + \delta)]}{(\alpha_A\alpha_B - \delta^2)\,2t}$$

Therefore $\partial\Lambda/\partial\gamma_A > 0$ if and only if

$$\gamma_A > \frac{(\alpha_A + \delta)}{(\alpha_A + \alpha_B + 2\delta)} - \frac{\lambda}{2} = \widetilde{\gamma}_A - \frac{\lambda}{2} \tag{28}$$

Therefore $\Lambda(\gamma_A)$ is U-shaped.

Then we calculate $\partial\Lambda/\partial\lambda$ and $\partial^2\Lambda/\partial\lambda\partial\gamma_A$.

$$\frac{\partial\Lambda}{\partial\lambda} = \frac{\gamma_A(\alpha_A + \alpha_B + 2\delta) - (\alpha_A + \delta)}{(\alpha_A\alpha_B - \delta^2)\,2t} < 0 \text{ if and only if } \gamma_A < \widetilde{\gamma}_A \tag{29}$$

$$\frac{\partial\Lambda}{\partial\lambda\partial\gamma_A} = \frac{(\alpha_A + \alpha_B + 2\delta)}{(\alpha_A\alpha_B - \delta^2)\,2t} > 0 \tag{30}$$

Finally, we evaluate $\Lambda(\widetilde{\gamma}_A)$. To obtain $\Lambda(\widetilde{\gamma}_A)$ we take into account that by definition $\frac{\partial e^A}{\partial p} = \frac{\partial e^B}{\partial p}$ for $\gamma_A = \widetilde{\gamma}_A$ (see equation (17)). Therefore equation (24) gives:

$$\Lambda(\widetilde{\gamma}_A) = \frac{\partial e^i}{\partial p} = \frac{(\alpha_B \widetilde{\gamma}_A - \delta(1-\widetilde{\gamma}_A))}{(\alpha_A \alpha_B - \delta^2)\, 2t} = \frac{1}{(\alpha_A + \alpha_B + 2\delta)\, 2t}. \tag{31}$$

Note that $\Lambda(\widetilde{\gamma}_A)$ does not depend on λ.

We can now construct Figure 1 which gives $\Lambda(\gamma_A)$ for three different values of λ. $\Lambda(\gamma_A)$ is U-shaped (equation (28)), does not depend on λ if and only if $\gamma_A = \widetilde{\gamma}_A$ (equations (31) and (30)) and is decreasing (increasing) in λ if and only if $\gamma_A < \widetilde{\gamma}_A$ ($\gamma_A > \widetilde{\gamma}_A$) (equation (29)). Furthermore, $\Lambda(0)$ is negative if and only if λ is large enough (equation (26)) while $\Lambda(1)$ is positive (equation (27)). In the solid line $\lambda = 0$. According to equation (28) the minimum of $\Lambda(\gamma_A)$ is reached at $\gamma_A = \widetilde{\gamma}_A$ when $\lambda = 0$. We have assumed that $D'(0) < 1/(\alpha_A + \alpha_B + 2\delta)\, 2t$ and therefore $\Lambda(\gamma_A) > D'(0)$ for $\lambda = 0$. In the dotted line $\lambda > 0$ but small enough so that $\Lambda(0) > D'(0)$. Finally, in the broken line $\lambda \geq \alpha_A/(\alpha_A + \delta)$ so that $\Lambda(0) < 0$. The proof makes use of Figure 1.

We first prove (i). For $\lambda \geq \overline{\lambda}$ the broken line is relevant. $\overline{\lambda}$ is the value of λ for which $\Lambda(0) = D'(0)$. Clearly there exists $\widehat{\gamma}_A$ such that $\Lambda(\gamma_A) \leq D'(0)$ for all $\gamma_A \in [0, \widehat{\gamma}_A]$. It is obvious from Figure 1 that $\widehat{\gamma}_A < \widetilde{\gamma}_A$, $\partial\widehat{\gamma}_A/\partial D'(0) > 0$ and $\partial\widehat{\gamma}_A/\partial\lambda > 0$.

Next we prove (iii). Now the solid line is relevant. $\underline{\lambda}$ is the value of λ for which the minimum point of Λ equals $D'(0)$, $\Lambda\left(\widetilde{\gamma}_A - \frac{\lambda}{2}\right) = D'(0)$ using equation (28). Clearly $\Lambda(\gamma_A) \geq D'(0)$ for all γ_A when $\lambda < \underline{\lambda}$.

Finally, we prove (ii). It follows from the previous that for $\lambda \in [\underline{\lambda}, \overline{\lambda})$ $\Lambda(0) \geq D'(0)$. Furthermore, $\Lambda'(0) < 0$ if the minimum point of Λ (given by equation (28)) is obtained for $\gamma_A > 0$.

$$\widetilde{\gamma}_A - \frac{\lambda}{2} > 0 \Leftrightarrow \lambda < \frac{2(\alpha_A + \delta)}{(\alpha_A + \alpha_B + 2\delta)} \tag{32}$$

Since we are examining a parameter range where $\overline{\lambda} < \alpha_A/(\alpha_A + \delta)$ (equation (26)) equation (32) holds for $\lambda \in [\underline{\lambda}, \overline{\lambda})$.

Therefore for $\lambda \in [\underline{\lambda}, \overline{\lambda})$ there exists $\underline{\gamma}_A$ and $\overline{\gamma}_A$ such that $\Lambda(\gamma_A) \leq D'(0)$ if and only if $\gamma_A \in [\underline{\gamma}_A, \overline{\gamma}_A]$. It is obvious from Figure 1 that $0 < \underline{\gamma}_A < \overline{\gamma}_A < \widehat{\gamma}_A$, $\partial\underline{\gamma}_A/\partial D'(0) < 0$, $\partial\underline{\gamma}_A/\partial\lambda < 0$, $\partial\overline{\gamma}_A/\partial D'(0) > 0$ and $\partial\overline{\gamma}_A/\partial\lambda > 0$.

Finally, we evaluate Λ for $\gamma_A = 1/2$.

$$\Lambda\left(\frac{1}{2}\right) = \frac{\frac{1}{2}\left(\alpha_A + \alpha_B - 2\delta\right) - \lambda\left(\alpha_A - \alpha_B\right)}{\left(\alpha_A \alpha_B - \delta^2\right) 4t} \tag{33}$$

For any $\lambda > 0$, $\Lambda\left(\frac{1}{2}\right)$ is decreasing in $(\alpha_A - \alpha_B)$ and is negative for $(\alpha_A - \alpha_B)$ large enough. Therefore $1/2 < \overline{\gamma}_A < \widehat{\gamma}_A$ for $(\alpha_A - \alpha_B)$ large enough. Q.E.D.

Proof of Proposition 3.

Straightforward from Figure 2. Assumption $D'(0) > 1/\left(\alpha_A + \alpha_B + 2\delta\right) 2t$ guarantees that there are values of γ_A for which $D'(0) > \Lambda\left(\gamma_A\right)$ for all $\lambda \geq 0$. $D'(0) < \alpha_B/2t\left(\alpha_A\alpha_B - \delta^2\right)$ guarantees that both values of γ_A for which $D'(0) = \Lambda\left(\gamma_A\right)$ when $\lambda = 0$ are within $(0, 1)$.

Proof of Proposition 4.

Given assumption $\mu_B/\mu_A \geq \alpha_B/\delta$ and $\delta > 0$, $e^A = 0$ under no competition. If $\partial e^A/\partial p > 0$, $e^A > 0$ under competition for $p > \underline{p} \equiv 2t(\delta\mu_B - \alpha_B\mu_A)/\left(\alpha_B\gamma_A - \delta\gamma_B\right)$. Proposition 4 combines the corner solution with the results of Proposition 1. Q.E.D.

References

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

[2] Besley, T. and M. Ghatak, (2005), "Competition and incentives with motivated agents", *American Economic Review*, 95(3), 616-636.

[3] Brekke, K., L. Siciliani and O.-R. Straume, (2008), "Competition and waiting times in hospital markets", *Journal of Public Economics*, 92, 1607-1628.

[4] Brekke, K., L. Siciliani and O.-R. Straume, (2010) "Price and Quality in Spatial Competition", *Regional Science and Urban Economic*s, 40, 471–480.

[5] Brekke, K., L. Siciliani and O.-R. Straume, (2011), "Quality competition with profit constraints: do nonprofit firms provide higher quality than for-profit firms?", CEPR Discussion Paper No. 8284.

[6] Chalkey M. and J. Malcomson, (1998), "Contracting for Health Services with Unmonitored Quality", *Economic Journal,* 108, 1093-1110.

[7] Delfgaauw, J. and R. Dur, (2007), "Signaling and Screening of Workers Motivation", *Journal of Economic Behavior and Organization*, 62(4), 605-624.

[8] Delfgaauw, J. and R. Dur, (2008), "Incentives and Workers Motivation in the Public Sector", *Economic Journal*, 118, 171-191.

[9] Eggleston, K., (2005), "Multitasking and mixed systems for provider payment", *Journal of Health Economics*, 24, 211-223.

[10] Ellis, R. P., (1998), "Creaming, skimping, and dumping: provider competition on the intensive and extensive margins", *Journal of Health Economics*, 17(5), 537-555.

[11] Ellis, R.P. and T. McGuire, (1986), "Provider behaviour under prospective re-imbursement: Cost sharing and supply", *Journal of Health Economics*, 5, 129-51.

[12] Federal Trade Commission, and U.S. Department of Justice, (2004), "Improving Health Care: A Dose of Competition." http://www.ftc.gov/reports/healthcare/040723healthcarerpt.pdf (accessed April 28, 2010).

[13] Fehr, E. and K.M. Schmidt, (1999), "A Theory Of Fairness, Competition, and Cooperation", *The Quarterly Journal of Economics*, 114(3), 817-868.

[14] Francois, P., (2000), "Public service motivation as an argument for government provision", *Journal of Public Economics*, 78, 3, 275-299.

[15] Gersbach, H. and M. Halonen-Akatwijuka, (2012), "Mixing private and public service providers and specialization", mimeo, University of Bristol.

[16] Gravelle, H., (1999), "Capitation contracts: access and quality", *Journal of Health Economics*, 18, 315–340.

[17] Gravelle, H. and P. Sivey, (2010), "Imperfect information in a quality-competitive hospital market", *Journal of Health Economics*, 29, 524–535

[18] Grossman, S. and O.D. Hart, (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration", *Journal of Political Economy,* 94 (4), 691-719.

[19] Halonen, M. and C. Propper, (2008), "Competition and Decentralisation in Government Bureaucracies", *Journal of Economic Behaviour and Organisation,* 67, 903–916.

[20] Hart, O. and J. Moore, (1990), "Property Rights and the Nature of Firms", *Journal of Political Economy,* 98 (6), 1119-58.

[21] Kaarbøe, O. and L. Siciliani, (2011), "Quality, Multitasking and Pay for Performance", *Health Economics*, 22(2), 225-238.

[22] Le Grand, J., (2003), *Motivation, Agency, and Public Policy: Of Knights, Knaves, Pawns, and Queens.* New York, NY: Oxford University Press.

[23] Newhouse, J. P., (1970), "Toward a theory of nonprofit institutions: an economic model of a hospital", *American Economic Review*, 60, 64-74.

[24] Rickman, N. and A. McGuire, (1999), "Regulating providers' reimbursement in a mixed market for health care", *Scottish Journal of Political Economy*, 46, 53-71.

[25] Vogt, W.B. and R.J. Town, (2006), "How Has Hospital Consolidation Affected the Price and Quality of Hospital Care?" Robert Wood Johnson Foundation Research Synthesis Report 9. http://www.rwjf.org/files/research/no9researchreport.pdf (accessed April 28, 2010).