Dedicated Doctors:
Public and Private Provision of Health Care with Altruistic Physicians

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January 11, 2007

Abstract

Physicians are supposed to serve patients' interests, but some are more inclined to do so than others. This paper studies how the system of health care provision affects the allocation of patients to physicians when physicians differ in altruism. We show that allowing for private provision of health care, parallel to (free) treatment in a National Health Service, benefits all patients. It enables rich patients to obtain higher quality treatment in the private sector. Because the altruistic physicians infer that in their absence, NHS patients receive lower treatment quality than private sector patients, they optimally decide to work in the NHS. Hence, after allowing for private provision, the remaining (relatively poor) NHS patients are more likely to receive the superior treatment provided by altruistic physicians. We also show, however, that allowing physicians to moonlight, i.e. to operate in both the NHS and the private sector simultaneously, nullifies part of these beneficial effects for the poorest patients.

Keywords: Altruism, Health care systems, Subsidy, Moonlighting.

JEL-codes: D64, H44, I11, I18.

1 Introduction

In the ongoing debate on the desirability of private provision of health care, one of the arguments voiced by opponents is that the private sector will attract the best physicians, implying that patients who have to rely on publicly provided care face a decrease in health care quality. In this paper, however, it is argued that if physicians differ in their concern for patient welfare, then those who care most about their patients actually prefer to provide high-quality treatment in the public sector rather than in a private practice. Ever since the ancient Greeks, it is common practice in many countries that physicians have to pledge to act in the interest of their patients before entering the profession. For instance, the Declaration of Geneva, a modern version of the Oath of Hippocrates adopted in 1948 by the General Assembly of the World Medical Association, contains the phrase "*the health of my patient will be my first consideration*". Similarly, the General Medical Council in the UK instructs doctors to "*make the care of your patient your first concern*" (General Medical Council, 2001).

There is ample anecdotal evidence of physicians living up to their oath. In the wake of extreme events, such as the September 11 attacks and hurricane Katrina, many physicians work around the clock to provide care.[1] *Médecins Sans Frontières* is able to find hundreds of health professionals willing to work in remote, undeveloped regions of the world, despite offering little remuneration. In a less extreme setting, over 70 percent of NHS employees in England claim to work more than their contractual hours, the majority working unpaid overtime. The most commonly mentioned reason for working overtime is "*to provide the best care I can for patients*" (Healthcare Commission, 2006). This suggests that at least some health professionals are willing to step beyond the boundaries of their contractual duties to provide better care. When we accept that physicians may differ in altruism towards their patients, we can ask: which patients benefit from the altruistic physicians? And relating to the discussion on private provision of health care, how is the allocation of these benefits affected by the system of

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[1] Several health professionals describe the events in New Orleans in Katrina's aftermath in the New England Journal of Medicine, Volume 353(15); see also CNN (2005).

health care provision?

This paper develops a model in which patients differ in income and physicians differ in altruism to analyse how different systems of health care provision affect the allocation of patients to doctors and, hence, patients' welfare. We compare a purely public system of health care provision, where all patients are treated in a National Health Service, to a mixed system of health care provision, where a perfectly competitive private health care sector exists parallel to the NHS. We show that allowing for private provision of health care benefits both rich and poor patients.

We distinguish between altruistic and regular physicians. Only altruistic physicians intrinsically care about patient welfare, but since their number is limited some patients will be treated by a regular doctor. Under both systems of health care provision, patients can obtain treatment for free in the NHS, financed through taxation, and physicians working for the NHS have to adhere to a minimum treatment quality. Patients who, under the mixed system, receive treatment in the private sector must pay the price of treatment themselves.[2] As any patient who is not treated by an altruistic physician will be treated by a regular physician, each altruistic physician infers that he can increase patient welfare by providing better treatment and, if treating patients in the private sector, by asking a lower price than regular physicians.

In the NHS, regular physicians provide the minimum treatment quality, whereas altruistic physicians optimally provide better treatment. We assume that in the NHS patients are randomly matched to physicians, and patients and physicians cannot observe each others' type. Hence, under purely public provision of health care, every patient has the same probability of receiving treatment from an altruistic physician. Under mixed provision, physicians decide whether to work for the NHS or set up a private practice and patients choose whether to obtain treatment in the NHS or buy treatment in the private sector. Competition ensures that regular physicians in the private sector must be equally well off as in the NHS. Obviously, free treatment in

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[2]Allowing for private health insurance does not affect the results if only rich patients buy insurance. Propper (2000) shows that insurance coverage in the UK indeed increases in income.

the NHS implies that the only way to attract patients to a private practice is to offer high-quality treatment, and only rich patients are willing to pay for high quality.[3]

We show that all patients are better off under mixed provision than under purely public provision, i.e. allowing for private provision of health care benefits both rich and poor patients. Rich patients are able to buy high-quality treatment in the private sector. As in Besley and Coate (1991), this leads to lower cost of public provision and, hence, to lower taxes. Altruistic physicians face the choice between improving the utility of a patient who otherwise pays for high-quality treatment in the private sector and providing higher treatment quality to a patient who otherwise receives low-quality treatment in the NHS. As the marginal benefit of additional treatment quality is higher for NHS patients than for private sector patients, working in the NHS is more rewarding for an altruistic physician. Hence, despite the opportunity to open up a private practice under mixed provision, altruistic physicians choose to stay in the NHS. This implies that the departure of rich patients benefits the remaining NHS patients (that is, the poor patients) by increasing their probability of receiving the superior treatment provided by altruistic physicians. Hence, since the 'best' doctors remain in the NHS, allowing for private provision of health care increases the expected treatment quality received by patients in the NHS.

This mechanism implies that not only allowing but also encouraging people to go to the private sector may have favourable consequences for NHS patients. Focussing on redistribution, Cullis and Jones (1985) show that subsidising private treatment can benefit those who do not make use of the subsidy through lower taxes, as long as the cost of the subsidy are smaller than the decrease in total cost of public provision.[4] In our framework, there is an additional beneficial effect of subsidising treatment in the private sector from the point of view of patients in the NHS. As the subsidy increases the

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[3]Apart from the distinction between altruistic and regular physicians, our setup is close to Besley and Coate (1991), who study the redistributional effects of public provision of private goods.

[4]Relatedly, Hoel and Sæther (2003) argue that a waiting list for treatment in the public sector can be beneficial to the poor despite the cost of waiting, as it drives rich people to the private sector.

number of patients who opt for treatment in the private sector, the remaining patients in the NHS have a higher probability of receiving the high-quality treatment provided by altruistic physicians.

Lastly, we analyse the effect of allowing physicians to 'moonlight', i.e. to operate in both the NHS and the private sector simultaneously. This gives physicians the possibility to transfer patients from the NHS to their private practice. Barros and Olivella (2005) and González (2005) analyse physicians' incentive to transfer the most profitable patients ('cream-skimming'). Ma (2004) and Biglaiser and Ma (2006) argue that moonlighting increases efficiency, as it allows for bargaining between regular doctors and their NHS patients to arrive at better treatment in a private practice.[5] In our framework, allowing for moonlighting is beneficial for some patients, but harmful for the poorest patients. The option of being transferred to a private practice when matched to a regular doctor induces more relatively rich patients to go initially to the NHS, as they need not fear receiving the minimum treatment quality anymore. This implies that for individual patients, the probability of being treated by an altruistic physician decreases. As the poor cannot afford a transfer to a private practice, they are adversely affected by moonlighting.

The next section discusses some related literature. Section 3 describes the model, and Section 4 compares purely public provision to mixed provision of health care. In Section 4, we also discusses the scope for subsidising private health care, and analyse the effects of moonlighting. Section 5 concludes.

2 Related literature

The assumption that some health care professionals are altruistic is not uncommon in the literature. Altruistic physicians have featured in several studies of the agency relation between physicians, patients, and/or purchasers of

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[5]Brekke and Sørgard (2006) argue that if doctors have market power, so that they can increase the profits from their private practice by reducing their labour supply, then allowing doctors to work in the private sector alongside a salaried job in the NHS may lead to a reduction in total health care capacity.

health care.[6] In Chalkley and Malcomson (1998), doctors care about treatment quality and can reduce the cost of treatment by exerting effort. Building on Ellis and McGuire (1986), they derive the optimal mix of prospective payment and cost-reimbursement when both effort and quality are unobservable to the purchaser. Jack (2005) generalises the results of Chalkley and Malcomson (1998) by deriving the optimal reimbursement scheme when physicians differ in altruism, see also Choné and Ma (2006).[7] Ma (2004) and Biglaiser and Ma (2006) assume that a group of dedicated doctors always provides high-quality treatment in the public sector and analyse the effects of allowing regular doctors to be employed in the public and the private sector simultaneously. In contrast to these papers, the current paper assumes that quality of treatment is verifiable and so does not look at optimal incentive schemes. Instead, we analyse how the system of health care provision affects which patients receive treatment from altruistic physicians.

As to the source of physicians' altruism, Arrow (1963) and Evans (1984) argue that physicians' concern for patient welfare has developed to reduce the adverse effects arising from the information asymmetry between patients and physicians. One aim of the extensive training of physicians is to install a sense of moral obligation towards patients into their beliefs and norms, so that they abstain from abusing their superior knowledge. These ethical considerations can be linked to the identity approach of Akerlof and Kranton (2000), where people prefer to behave like people in 'their' social class are supposed to behave. Applied to physicians, this would imply that physicians act in the interest of patients so as to comply with the ideal of a good physician.

Our setup is close to the literature on the redistributive aspects of public provision of private goods. In Besley and Coate (1991), the poor obtain a free but low-quality good in the public sector, whereas the rich prefer to

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[6] For a discussion of the interdependence of physicians' and patients' utility, see Mooney and Ryan (1993). McGuire (2000) surveys the physician agency literature.

[7] Heyes (2005) argues that if nurses differ in their intrinsic motivation to provide care, paying higher wages may attract less motivated personnel. For similar arguments in a more general context, see Dixit (2002) and Delfgaauw and Dur (2005). Besley and Ghatak (2005), Delfgaauw and Dur (2004), and Francois (2000) argue that organisations' ability to attract workers who value working for the organisation reduces the need for providing monetary incentives.

buy a high-quality good in the private sector. Even when public provision is financed by a head tax, this has redistributional consequences, as the taxes paid by the rich help to pay for the provision of the good to the poor. This mechanism also operates in an optimal taxation framework, see e.g. Blomquist and Christiansen (1995) and Boadway and Marchand (1995). Epple and Romano (1996a,b) and Gouveia (1997) show in a median voter setting that there is always a majority favouring a mixed system of public and private provision over a system of either solely public or solely private provision.[8] Our contribution lies in the addition of differences in providers' concern for customer welfare, which turn out to strengthen the case for mixed provision. Moreover, we show that it increases the scope for subsidising private provision.

3 The model

There is a population of patients of size P.[9] Patients differ only in income $Y \in [Y_L, Y_H]$. Income is continuously distributed according to density function $f(Y)$ with cumulative distribution function $F(Y)$. Each patient needs treatment from a physician; physicians cannot observe a patient's income. Patients' utility $u(y, q)$ depends on the quality of their treatment q and on the consumption of a composite good y. For simplicity, we assume that utility is separable in income and treatment quality:

$$u(y, q) = U(y) + V(q) \tag{1}$$

Utility is increasing and concave in both elements: $U_y > 0, U_{yy} < 0, V_q > 0, V_{qq} < 0$.

We distinguish between two systems of health care provision. In the purely public system, treatment is provided within a National Health Service only. In the mixed system of health care provision, there is private provision of health care parallel to the NHS. Under both systems, treat-

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[8]Jofre-Bonet (2000) models strategic interaction between public and private providers of health care, and concludes that mixed provision outperforms both purely private and purely public provision.

[9]We assume that there are no healthy people. None of the results is affected if each person needs treatment with a given probability.

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ment in the NHS can be obtained free of charge. The NHS runs a balanced budget, and the cost of public provision of health care are financed by a proportional income tax τ. We assume that treatment quality is verifiable. Physicians working in the NHS are obliged to provide at least treatment quality $\bar{q}$ and receive a salary from the NHS. Under the mixed system, patients and physicians choose between the NHS and the perfectly competitive private sector. In the private sector, physicians offer one or more bundles of treatment quality and price and patients must pay the price of treatment themselves.[10]

There are two types of physicians: regular and altruistic physicians. Each physician treats at most one patient. In total, there are sufficient physicians to treat all patients, but there is a limited number $N < P$ of altruistic physicians. Hence, some patients are treated by regular physicians. For convenience, we normalise the utility of both physician types from working outside health care to zero.

Regular doctors have standard preferences:

$$Z^R = w - c(q)$$

where w is the financial reward a doctor obtains for treating a patient, and $c(q)$ denotes the effort cost of providing treatment of quality q, with derivatives $c_q > 0$ and $c_{qq} \geq 0$. Thus, providing higher treatment quality becomes increasingly more costly.[11] As there are sufficient doctors, the participation constraint of regular doctors will be binding. This implies that for providing treatment of quality q, regular doctors must receive compensation $w = c(q)$.

The preferences of altruistic doctors are similar to the preferences of regular doctors, except that an altruistic doctor to some extent cares about patients' utility. More specifically, an altruistic doctor values increasing the utility of a patient above the level of utility this patient would have obtained

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[10] Allowing for private health insurance, such that the cost of treatment in the private sector is zero at the point of consumption, does not affect the results, as long as only rich patients buy insurance. Propper (2000) shows that the likelihood of taking private insurance in the UK indeed increases in income.

[11] Observe that doctors' utility is assumed to be linear in income, whereas patients' utility is concave in income. This is solely for simplicity, and does not affect any of the results qualitatively.

elsewhere. Equivalently, altruistic doctors may care about total patient welfare, which increases when an altruistic doctor provides his patient with greater utility than this patient would have received had she not been treated by this doctor.[12] This is captured by the utility function of altruistic doctors:

$$Z^A = w - c(q) + \gamma[u(y, q) - u^o] \tag{2}$$

where γ is the weight of altruism in the utility function and u^o is the 'outside option' of the patient. Clearly, patients will not accept lower utility from treatment by an altruistic doctor than u^o. Hence, the last term in the utility function of altruistic doctors is nonnegative. Altruistic doctors can increase the utility of their patient by providing higher treatment quality than this patient would otherwise receive, and, if working in the private sector, by asking a lower price for treatment.[13] Notice that altruistic physicians care about the absolute increase in utility, irrespective of whether the patient is rich or poor. Allowing altruistic physicians to place greater weight on the utility of poor patients than on the utility of rich patients strengthens the results.

Whereas physicians working in the NHS receive a salary, physicians in the private sector are free to choose the price of their treatment. We impose one reasonable restriction on physicians' choices:

Assumption 1: $w \geq 0$.

Assumption 1 precludes situations where physicians are so altruistic that when they work in the private sector, they charge negative prices. In reality, physicians may be tempted to, on top of free treatment, slip some money to very needy patients. This, however, must be the exception rather than the rule, as one cannot live on altruistic utility alone.[14]

We assume that the process of matching patients and physicians is in-

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[12] This implies that the altruistic physicians inhabit pure altruism, as in Francois (2000). Instead, in Delfgaauw and Dur (2004), Glazer (2004) and Besley and Ghatak (2005) agents are impurely altruistic, which implies that they care about their personal contribution to output ('warm-glow').

[13] Given that patients' utility is concave in income, altruistic doctors would prefer spreading money over all (poor) patients rather than granting one patient a large reduction in the price of treatment. We assume that physicians do not engage in redistribution.

[14] An equivalent assumption is made in Ma (2004) and Choné and Ma (2006).

stantaneous and costless, and we abstract from coordination problems such that each patient is matched to one physician. In the NHS, patients are assigned randomly to physicians, and do not observe the type of their physician before treatment. We assume that if an altruistic physician wants to work in the NHS, he is always matched to a patient. In the private sector, patients are assigned to their most preferred type of physician with probabilities depending upon supply and demand for this physician type. For instance, if all altruistic physicians work in the private sector and $M > N$ patients want to be treated by an altruistic physician, then each of the M patients has probability N/M to be matched to an altruistic physician and the remainder is treated by a regular physician in the private sector.

4 Results

4.1 Purely public provision

Suppose that the NHS is the only provider of health care. The NHS enforces the (exogenously given) minimum treatment quality $\bar{q}$, and because there are not sufficient altruistic physicians to treat all patients, the NHS must employ regular physicians. To attract regular physicians, the NHS must offer a wage $w = c(\bar{q})$. Since regular physicians have no incentive to provide better quality than $\bar{q}$, patients with income Y_i treated by a regular physician in the NHS obtain utility $u[(1-\tau_p)Y_i, \bar{q}]$. Each altruistic physician infers that if he does not treat a patient, one more patient will be treated by a regular physician. Hence, patients' outside option u^o is the utility a patient obtains from treatment by a regular physician. From (2), it follows that altruistic doctors who provide treatment quality $\bar{q}$ are also willing to work in the NHS for salary $w = c(\bar{q})$. However, since altruistic physicians care about patients' utility, they may choose to deviate from the treatment offered by regular physicians. Altruistic physicians cannot affect the price of treatment for the patient (which equals zero in the NHS), but may optimally decide to provide better treatment quality.[15] Note that if an altruistic doctor is willing to provide better quality, he is also willing to accept a lower wage

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[15] Allowing for a monetary transfer from a physician to his NHS patient does not affect the results.

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than regular doctors. In theory, the NHS could extract the rents of altruistic doctors by offering a wage scheme which is decreasing in treatment quality. This seems unrealistic and difficult to enforce, and hence we will assume that the NHS sticks to one wage for all doctors: $w = c(\bar{q})$. Total cost of purely public provision of health care thus equals $c(\bar{q})P$, yielding tax rate $\tau_p = c(\bar{q})/\int_{Y_L}^{Y_H} Y f(Y) dY$.

Substituting for w and u^o in the utility function of altruistic physicians (2) and taking account of the random matching of patients and physicians gives:

$$Z^A = c(\bar{q}) - c(q) + \gamma \int_{Y_L}^{Y_H} \{u[(1-\tau_p)Y, q] - u[(1-\tau_p)Y, \bar{q}]\} f(Y) dY \quad (3)$$

An altruistic physician maximises utility with respect to q, subject to $q \geq \bar{q}$. Using (1), let q^A be the resulting optimal level of treatment quality, as given by first-order condition:

$$-c_q(q^A) + \gamma V_q(q^A) = 0 \quad (4)$$

Note that q^A does not depend on the (expected) income of the patient. Using the treatment quality provided by regular physicians $\bar{q}$, it follows from (4) that altruistic physicians provide higher treatment quality than their less altruistic colleagues if:

$$\gamma V_q(\bar{q}) > c_q(\bar{q}) \quad (5)$$

Otherwise, altruistic physicians offer the same treatment as regular physicians. Hence, if altruistic physicians are sufficiently altruistic, i.e. if γ is sufficiently high, then they provide higher treatment quality than regular physicians, thereby increasing both the utility of their patient and their own utility. Throughout the paper, we will assume that condition (5) is satisfied. It follows that patients have probability N/P to be treated by an altruistic physician, in which case they receive treatment quality q^A, and with the remaining probability they obtain treatment quality $\bar{q}$ from a regular physician.

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4.2 Mixed provision

Now suppose that a perfectly competitive private sector of health care provision exists parallel to the NHS. Each physician chooses whether to work for the NHS or in the private sector, and each patient decides whether to obtain treatment in the NHS or in a private practice. We focus on an equilibrium where some patients are being treated in the private sector and others in the NHS. We will show that in equilibrium, all altruistic physicians work in the NHS, relatively poor patients receive treatment in the NHS, and rich patients buy treatment in the private sector.

Since there are sufficient physicians, competition between regular physicians ensures that they are indifferent between working in the NHS and working in the private sector. In the previous subsection, we have seen that regular physicians in the NHS provide treatment quality $\bar{q}$ and receive wage $w = c(\bar{q})$. This implies that regular physicians in a private practice are willing to provide quality q at price $w = c(q)$. Hence, a patient with income Y_i who buys treatment from a regular physician in the private sector maximises utility (1), subject to the budget constraint $y + c(q) = (1 - \tau_m)Y_i$, where τ_m is the tax rate needed to cover the cost of public provision of health care under the mixed system. Optimal treatment quality q_i^* is implicitly given by first-order condition:

$$-c_q(q_i^*)U_y[(1 - \tau_m)Y_i - c(q_i^*)] + V_q(q_i^*) = 0 \qquad (6)$$

This yields utility $u[(1 - \tau_m)Y_i - c(q_i^*), q_i^*]$. Concavity of $U(\cdot)$ and $V(\cdot)$ ensures that both treatment quality q_i^* and consumption of the composite good are increasing in income.

Obviously, the availability of free treatment quality $\bar{q}$ in the NHS implies that patients are only willing to pay for treatment in the private sector if the treatment quality they receive is sufficiently greater than $\bar{q}$. This immediately implies that the price regular physicians receive for treating a patient in the private sector is higher than the wage a regular physician earns when working in the NHS. The benefits of these higher earnings, however, are fully offset by the cost of providing higher treatment quality.

In the previous subsection we have seen that the optimal treatment qual-

ity provided by altruistic physicians in the NHS is independent of the (expected) income of patients in the public sector. Hence, given that condition (5) is fulfilled, altruistic physicians who operate in the NHS optimally provide treatment quality q^A, as implicitly defined by (4).

Lemma 1 describes patients' choice between treatment in the NHS and treatment in the private sector.

Lemma 1 *Consider any combination of treatment bundles offered in the private sector for which some patients choose treatment in the NHS and other patients choose treatment in the private sector. There is one level of income at which patients are indifferent between the NHS and the private sector. Let Y_M denote this endogenously determined level of income. Patients with income $Y_i > Y_M$ buy treatment in the private sector, whereas patients with income $Y_i < Y_M$ receive treatment in the NHS.*

Proof. Suppose that patients in the NHS have probability α to be matched to an altruistic physician. For a patient with income Y_i, expected utility from treatment in the NHS then equals:

$$Eu_{nhs} = \alpha u[(1 - \tau_m)Y_i, q^A] + (1 - \alpha) u[(1 - \tau_m)Y_i, \bar{q}] \qquad (7)$$

Consider a bundle of treatment quality q' and cost w' offered by one or more altruistic physicians in the private sector. Suppose that patients who apply for treatment by an altruistic physician in the private sector who offers this treatment bundle have probability β to be matched to an altruistic physician. Then, the expected utility of a patient with income Y_i from applying for treatment by an altruistic physician in the private sector equals:[16]

$$Eu_{priv} = \beta u[(1 - \tau_m)Y_i - w', q'] + (1 - \beta) u[(1 - \tau_m)Y_i - c(q_i^*), q_i^*] \qquad (8)$$

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[16] The choice of a single patient between the NHS and private health care affects the cost of public provision and, hence, the tax rate τ_m. However, in a sufficiently large population this effect is small, and for notational convenience we assume throughout the paper that individual patients neglect this tax effect in deciding whether to opt for treatment in the NHS or in the private sector.

Differentiating (7) and (8) with respect to Y_i gives, using (1):

$$\frac{\partial Eu_{nhs}}{\partial Y_i} = (1 - \tau_m)U_y[(1 - \tau_m)Y_i]$$

$$\frac{\partial Eu_{priv}}{\partial Y_i} = (1 - \tau_m)\{\beta U_y[(1 - \tau_m)Y_i - w'] + (1 - \beta)U_y[(1 - \tau_m)Y_i - c(q_i^*)]\}$$

where the effects through a change in q_i^* are zero by the envelop theorem. Using assumption 1 and $U_{yy} < 0$, it follows that for any α, β, and bundle of treatment quality q' and cost w', we have for any given level of Y_i that $\frac{\partial Eu_{nhs}}{\partial Y_i} < \frac{\partial Eu_{priv}}{\partial Y_i}$.[17] Hence, for any treatment bundle offered by altruistic physicians in the private sector, expected utility from private treatment increases more strongly with income than expected utility from treatment in the NHS.[18] It follows that if there is any treatment bundle offered by altruistic physicians in the private sector that makes that a patient with income Y_i prefers treatment in the private sector over treatment in the NHS, then all patients with higher income also prefer treatment in the private sector. Similarly, if given all treatment bundles offered, a patient with income Y_i prefers treatment in the NHS, then all patients with lower income also prefer the NHS over the private sector. It follows that given all treatment bundles offered in the private sector, there can be only one patient type indifferent between treatment in the NHS and treatment in the private sector. ∎

The intuition behind Lemma 1 is given with the help of Figure 1, which depicts patients' utility from treatment in the NHS and treatment the private sector when all altruistic physicians work in the NHS. In the NHS, patients receive either treatment quality q^A or $\bar{q}$, and, hence, the expected utility from treatment in the NHS lies in between the two relatively flat curves. Since patients have to pay for treatment by a regular physician in the private sector and $U_{yy} < 0$, utility from private sector treatment increases more strongly with income than utility from NHS treatment. By definition, at income level

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[17]Note that is it not possible that $\beta = 1$ and $w' = 0$ simultaneously, since offering costless treatment in the private sector that is attractive to any patient attracts all patients who prefer treatment in the NHS over treatment by a regular physician in the private sector. This either violates $\beta = 1$ or the restriction that some patients must prefer treatment in the NHS.

[18]Note that this argument also holds when altruistic physicians offer the same treatment bundles as regular physicians or, equivalently, if no altruistic physician works in the private sector.

Figure 1: Patients' utility

Figure 1: Patients' utility

$u[(1-\tau_m)Y_i - c(q_i^*), q_i^*]$

$u[(1-\tau_m)Y_i, q^A]$

Eu_{nhs}

$u[(1-\tau_m)Y_i, \bar{q}]$
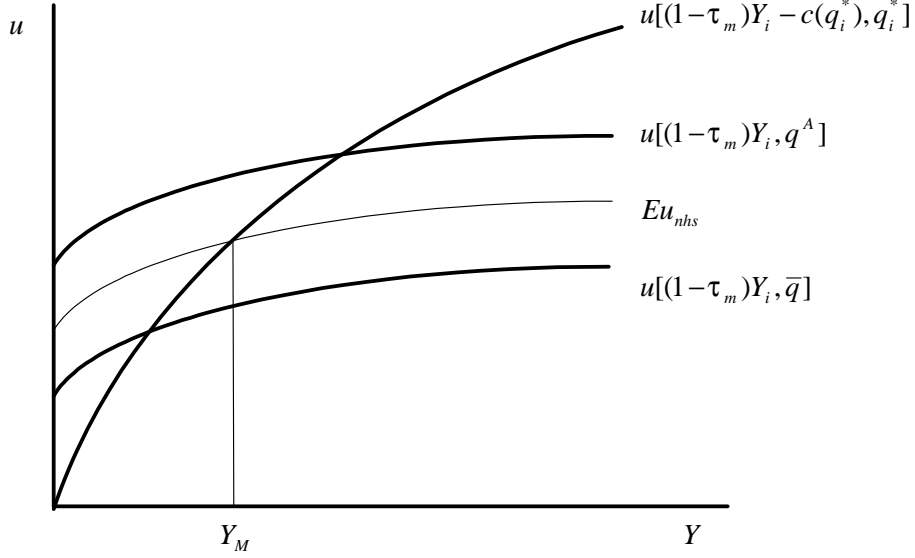
Y_M the expected utility from treatment in the NHS equals the utility from treatment by a regular physician in the private sector. Patients with income above Y_M choose to buy treatment in the private sector, whereas patients with income smaller than Y_M receive treatment in the public sector. This yields yields tax rate $\tau_m = F(Y_M)c(\bar{q})/\int_{Y_L}^{Y_H} Y f(Y) dY$.

Now consider any treatment bundle offered by an altruistic physician in the private sector. By $U_{yy} < 0$ and assumption 1, the slope of a curve depicting the utility derived from this treatment bundle cannot be flatter than the slopes of the curves describing the utility from treatment in the NHS. Hence, treatment bundles offered by altruistic physicians in the private sector can shift Y_M to the left, but cannot solely attract the poorest patients.

Lemma 1 implies that in equilibrium the poorest patients are treated in the NHS whereas the richest patients buy treatment in the private sector. Hence, altruistic physicians know that if they decide to work in a private practice, they will treat a relatively rich patient, whereas if they work for the NHS, they get to treat a relatively poor patient. Proposition 1 gives the equilibrium allocation of patients and altruistic physicians.

Proposition 1 *In an equilibrium where some patients choose treatment in the NHS and other patients choose treatment in the private sector, all altruistic physicians work in the NHS. The allocation of patients is as described by Lemma 1, with Y_M implicitly determined by:*

$$\frac{N}{F(Y_M)P}u[(1-\tau_m)Y_M, q^A] + \left(1 - \frac{N}{F(Y_M)P}\right)u[(1-\tau_m)Y_M, \bar{q}] = u[(1-\tau_m)Y_M - c(q_M^*), q_M^*]$$

(9)

This equilibrium exists if $Y_L < Y_M < Y_H$, which is satisfied when:

$$u[(1-\tau_m)Y_L, \bar{q}] > u[(1-\tau_m)Y_L - c(q_L^*), q_L^*]$$

and

$$\frac{N}{P}u[(1-\tau_m)Y_H, q^A] + \left(1 - \frac{N}{P}\right)u[(1-\tau_m)Y_H, \bar{q}] < u[(1-\tau_m)Y_H - c(q_H^*), q_H^*]$$

Proof. See Appendix. ∎

The intuition behind Proposition 1 is straightforward. By working for the NHS, an altruistic physician can increase the utility of a relatively poor patient who otherwise receives treatment quality $\bar{q}$ from a regular physician. Alternatively, he can increase the utility of a relatively rich patient in the private sector, by providing better quality at a lower price than the patient otherwise buys from a regular physician. Since the treatment quality provided by regular physicians in the private sector must be higher than $\bar{q}$, the marginal benefit of an increase in treatment quality is higher for NHS patients than for private sector patients. Hence, for altruistic physicians, providing better treatment quality than regular physicians is more rewarding when treating a patient in the NHS. Although altruistic physicians can further increase the utility of patients in the private sector by offering a lower price for treatment than regular physicians, this additional instrument is not effective enough to outweigh the higher utility gain patients in the NHS obtain from the increase in treatment quality.[19]

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[19]It immediately follows that if the private sector patients have bought private health insurance, such that their cost of treatment is zero at the point of consumption, altruistic physicians are even more inclined to treat NHS patients. Hence, allowing for private insurance does not affect the results.

For patients, the equilibrium is captured in Figure 1. The presence of altruistic physicians in the NHS makes treatment in the NHS attractive. However, treatment quality is uncertain in the NHS (either q^A or $\bar{q}$), whereas a patient buys a certain treatment quality in the private sector, as given by (6). For sufficiently rich patients, even treatment by an altruistic physician in the NHS is not good enough. Somewhat poorer patients do prefer treatment by an altruistic physician in the NHS over treatment in the private sector, but choose to buy treatment in the private sector so as to avoid the possibility of being treated by a regular physician in the NHS. Still poorer patients also prefer treatment by a regular physician in the private sector over treatment by a regular physician in the NHS, but the difference in utility is small enough so that the presence of altruistic physicians in the NHS makes it worthwhile to run the risk of ending up with treatment quality $\bar{q}$. The poorest fraction of patients simply prefers either treatment in the NHS over treatment by a regular physician in the private sector.

4.3 Comparing purely public and mixed provision

Proposition 2 compares the purely public system of health care provision with the mixed system of health care provision, from the patients' point of view.

Proposition 2 *Allowing for private provision of health care benefits all patients.*

Proof. Under purely public provision, all patients have probability N/P to receive treatment quality q^A and otherwise receive quality $\bar{q}$. Hence, the expected utility of a patient with income Y_i under public provision is:

$$Eu(y,q) = \frac{N}{P}u[(1-\tau_p)Y_i, q^A] + \left(1 - \frac{N}{P}\right)u[(1-\tau_p)Y_i, \bar{q}] \qquad (10)$$

Proposition 1 has shown that under a mixed system of health care provision, i.e. when private provision of health care is allowed for, relatively rich patients buy treatment in the private sector, even though all altruistic physicians work in the NHS. This immediately implies that these patients are better off under the mixed system than under the purely public system,

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as otherwise they would not leave the NHS. Under mixed provision, patients in the NHS have probability $N/F(Y_M)P$ to be treated by an altruistic physician, implying that for a patient with income Y_i the expected utility from treatment in the NHS is given by:

$$Eu_{nhs}(y,q) = \frac{N}{F(Y_M)P}u[(1-\tau_m)Y_i, q^A] + \left(1 - \frac{N}{F(Y_M)P}\right)u[(1-\tau_m)Y_i, \bar{q}]$$

(11)

As $\tau_p > \tau_m$ and $0 < F(Y_M) < 1$, it follows that the expected utility of treatment in the NHS is higher under mixed provision than under purely public provision. ∎

Intuitively, rich patients benefit from private provision of health care, as they are able to secure high-quality treatment in the private sector. The withdrawal of the rich patients from the NHS benefits the remaining NHS patients in two ways. First, the tax rate decreases, as less patients make use of the public service. Second, since all altruistic physicians optimally decide to work in the NHS, the probability to be matched to an altruistic physician in the NHS increases. Hence, on average, NHS patients receive higher treatment quality under mixed provision than under public provision.[20]

4.4   Subsidising private health care

Proposition 2 has shown that allowing for private provision of health care alongside public provision benefits relatively poor patients by attracting the rich patients to the private sector. In other words, in expected terms a patient in the NHS gains from a reduction in the number of her fellow NHS patients. This suggests a role for subsidising private health care.

Suppose that every patient treated in the private sector receives a, possibly negative, subsidy s, with the restriction that s should not be larger than the cost of treatment. The total cost of health care provision then equals

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[20]If altruistic physicians place greater weight on the utility of relatively poor patients than on the utility of richer patients, poor patients benefit even more from private provision. As altruistic physicians infer that on average they treat a poorer patient under mixed provision than under public provision, they optimally provide even better treatment quality under mixed provision.

$\{F(Y_M)c(\bar{q}) + [1 - F(Y_M)]s\}P$, yielding tax rate:

$$\tau_s = \{F(Y_M)c(\bar{q}) + [1 - F(Y_M)]s\}/\int_{Y_L}^{Y_H} Yf(Y)dY$$

It is easily verified that, analogous to Proposition 2, all patients prefer mixed provision with any $s \leq c(\bar{q})$ at which some patients seek treatment in the private sector over a purely public system (or, equivalently, a prohibitive tax on private treatment). Clearly, the patients opting for private care are better off by revealed preference. When $s < c(\bar{q})$, all patients benefit from a reduced tax burden, as each patient treated in the private sector reduces the cost of health care provision by $c(\bar{q}) - s$. When $s = c(\bar{q})$, mixed provision is essentially a voucher system, where every patient receives a voucher which can be used to obtain treatment quality $\bar{q}$ in both the NHS and the private sector. The cost of this voucher system are identical to the cost of a purely public system. However, the presence of altruistic physicians in the NHS implies that the remaining patients in the NHS also strictly prefer the voucher system over the purely public system, as the withdrawal of the relatively rich patients from the pool of NHS patients increases their probability of being treated by an altruistic physician.

Let us now consider the effect of an increase in subsidy s. Given a subsidy s, the expected utility of a patient with income Y_i who opts for treatment in the NHS is given by (11) with τ_m replaced by τ_s. When treated in the private sector, this patient's utility equals

$$u_{priv}(y, q) = U[(1 - \tau_s)Y_i - c(q_i^*) + s] + V(q_i^*)$$

where q_i^* is defined by the first-order condition for optimal treatment quality in the private sector (6) with $(1 - \tau_m)Y_i = (1 - \tau_s)Y_i + s$. Recall that by definition, Y_M is the endogenously determined level of income at which a patient is indifferent between treatment in the NHS and treatment in the private sector.

The effect of a marginal increase in s on the total cost of health care

provision and, hence, on the tax rate is ambiguous:

$$\frac{\partial \tau_s}{\partial s} = \frac{[c(\bar{q}) - s]f(Y_M)\dfrac{\partial Y_M}{\partial s} + [1 - F(Y_M)]}{\int_{Y_L}^{Y_H} Y f(Y) dY} \tag{12}$$

The first term in the numerator gives the net savings from the reduction in the number of patients treated in the NHS, and the second term gives the increase in infra-marginal subsidies paid to the private sector patients. Using (1), we find that a marginal increase in s affects the utility from treatment in the NHS (11) through the tax rate and through a change in the probability of treatment by an altruistic physician:

$$\frac{\partial Eu_{nhs}(y, q)}{\partial s} = -Y_i \frac{\partial \tau_s}{\partial s} U_y[(1-\tau_s)Y_i] - \frac{Nf(Y_M)}{PF(Y_M)^2}\frac{\partial Y_M}{\partial s}\{V(q^A) - V(\bar{q})\} \tag{13}$$

The utility from private treatment is affected directly by the change in the subsidy and indirectly through the change in the tax rate (the effect through q_i^* is zero by the envelop theorem):

$$\frac{\partial u_{priv}(y, q)}{\partial s} = \left(1 - Y_i \frac{\partial \tau_s}{\partial s}\right) U_y[(1 - \tau_s)Y_i - c(q_i^*) + s] \tag{14}$$

It follows that an increase in s reduces the number of patients treated in the NHS. If Y_M would not change, the second term of (13) would vanish. However, since $(1 - Y_M[\partial \tau_s/\partial s]) > 0$ and $U_y[(1 - \tau_s)Y_i - c(q_i^*) + s] \geq U_y[(1 - \tau_s)Y_i] > 0$ for all patients, that would imply that treatment in the private sector becomes more attractive to patients with income Y_M relative to treatment in the NHS.[21] Hence, the patients who were indifferent at the original level of s now prefer treatment in the private sector, implying that Y_M must decrease: $\partial Y_M/\partial s < 0$.

If the effect of the reduction of the number of NHS patients in (12) outweighs the effect of the increase in infra-marginal subsidies, then a higher subsidy leads to lower cost of health care provision and, hence, lower taxes, $\partial \tau_s/\partial s < 0$. This implies that everyone benefits from a higher subsidy, as can be seen from (13) and (14). The increase in s reduces the (public) cost

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[21] That $(1 - Y_M[\partial \tau_s/\partial s]) > 0$ when $\partial Y_M/\partial s = 0$ follows from (12). For any $Y_M < Y_H$ it holds that $\int_{Y_M}^{Y_H} Y f(Y) dY > [1 - F(Y_M)]Y_M$.

of health care provision and increases the (expected) treatment quality for all patients.

Now suppose that the increase in s increases total health care cost. From (14), it follows that private sector patients generally benefit from the higher subsidy.[22] NHS patients are hurt by the increase in the tax. However, (13) shows that they may still benefit from the higher subsidy, since the probability of receiving treatment from an altruistic physician increases. Hence, for NHS patients, the presence of altruistic physicians makes subsidising treatment in the private sector more appealing.

The discussion in this subsection is summarised in the Proposition 3.

Proposition 3 *The presence of altruistic physicians increases the benefits of subsidising private provision of health care.*

4.5 Moonlighting

We have assumed that under the mixed system, physicians either work for the NHS or work in a private practice. In this subsection, we study the effects of allowing for 'moonlighting', i.e. allowing physicians to operate in a private practice alongside their NHS job. This enables physicians to transfer their NHS patients to their private practice, if this is mutually beneficial.[23] For a monopolistic doctor in the private sector, this gives an incentive to select highly profitable patients for treatment in the private sector (Barros and Olivella, 2005, González, 2005). Ma (2004) and Biglaiser and Ma (2006) show that moonlighting can increase efficiency by enabling a patient and a physician to share the surplus arising from a transfer to the private sector, in a model where the number of patients who enter the NHS is fixed.

In our framework, allowing for moonlighting benefits some patients, but has adverse effects on the poorest patients by increasing the number of patients who (at least initially) opt for treatment in the NHS. As shown in Figure 1, when moonlighting is not allowed relatively poor private sector

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[22]If the income distribution is sufficiently skewed, then it is possible that the increase in taxes paid by patients with top incomes outweighs the increase in subsidy received.

[23]In our setup, this is identical to assuming that patients in the NHS observe their physician's type before treatment and are able to subsequently withdraw from the NHS and enter the private sector.

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Figure 2: The effect of moonlighting on patients' utility
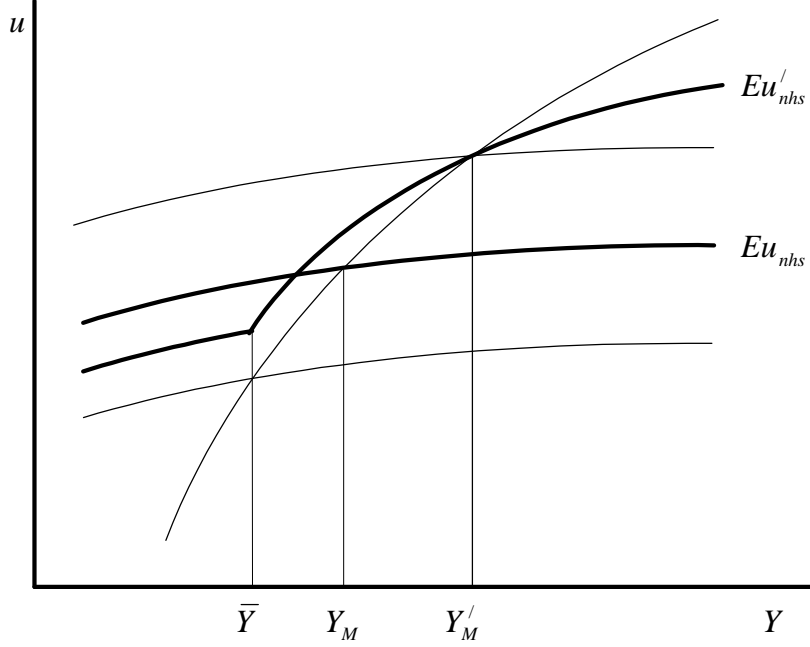
patients would obtain higher utility from treatment by an altruistic physician in the NHS than from their treatment in the private sector. They refrain from treatment in the NHS because they fear receiving the low-quality treatment provided by regular physicians in the NHS. Similarly, for some relatively rich NHS patients, the utility of treatment by a regular physician in the private sector exceeds the utility of treatment by a regular physician in the NHS.

Figure 2 extents Figure 1 to show the effects of moonlighting. Allowing for moonlighting implies that patients matched to a regular physician in the NHS can choose between receiving quality $\bar{q}$ for free and buying their optimal treatment quality in the private sector, as given by (6). Hence, as depicted in Figure 2, all patients with income $Y_i > \bar{Y}$ are willing to be transferred to the private sector after being matched to a regular physician in the NHS, where $\bar{Y}$ is implicitly defined by:

$$u[(1 - \tau_m)\bar{Y}, \bar{q}] = u[(1 - \tau_m)\bar{Y} - c(\bar{q}^*), \bar{q}^*]$$

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However, since the relatively poor private sector patients need not fear receiving treatment quality $\bar{q}$ anymore, more patients will apply for treatment in the NHS, in the hope of receiving treatment from an altruistic physician. In fact, all patients who obtain higher utility from treatment by an altruistic physician in the NHS than from treatment a regular physician in the private sector have an incentive to go to the NHS. This implies that the income at which patients are indifferent between applying for treatment in the NHS and in the private sector increases from Y_M to Y'_M, where Y'_M is implicitly defined by:

$$u[(1 - \tau_m)Y'_M, q^A] = u[(1 - \tau_m)Y'_M - c(q'^*_M), q'^*_M]$$

As regards patients' utility, Figure 2 shows that allowing for moonlighting implies that the expected utility from opting for treatment in the NHS shifts from Eu_{nhs} to Eu'_{nhs}.[24] Clearly, relatively rich NHS patients as well as private sector patients with income up to Y'_M benefit from moonlighting. However, moonlighting harms the poorest patients. They do not gain (enough) from the opportunity to buy higher quality treatment when matched to a regular physician, and because more patients opt for treatment in the NHS, they have a lower probability of receiving the high-quality treatment provided by altruistic physicians.

Proposition 4 summarises the arguments made in this subsection.

Proposition 4 *Allowing physicians to transfer NHS patients to their private practice is beneficial for patients with middle/high income, but harms the poorest patients.*

5   Concluding remarks

This paper has shown that physicians who intrinsically care about patients' well-being favour working in the public sector over working in a private practice. Altruistic physicians can have greater impact on patients' welfare

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[24]Here, we abstract from changes in the tax rate. The effect of allowing for moonlighting on the total cost of health care provision is ambiguous. Without moonlighting, the cost are $c(\bar{q})F(Y_M)P$. With moonlighting the cost are uncertain, as it depends on the matching of physicians and patients. Expected cost are equal to $c(\bar{q})\{F(\bar{Y})P + [1 - F(\bar{Y})/F(Y'_M)]N\}$.

by treating poor public sector patients than by treating rich private sector patients, as the latter are able to buy high-quality treatment themselves. This implies that allowing for private provision of health care also benefits the patients who cannot afford treatment in a private practice. When the rich buy high-quality treatment in the private sector, the remaining NHS patients have a higher probability to be treated by one of the altruistic physicians. Along the same lines, we have argued that subsidising private provision of health care also benefits patients are treated in the NHS, by further increasing the number of patients who leave for the private sector. Conversely, allowing physicians to transfer patients from the NHS to a private practice harms the poorest patients, as the resulting increase in the number of NHS patients implies that their probability of treatment by an altruistic physician decreases.

We have assumed that physicians treat the same number of patients in the NHS as in the private sector. Concavity of patients' utility function implies that altruistic physicians would prefer to improve the treatment of many patients a little over greatly improving the treatment of a few. If altruistic physicians could treat more patients in a private practice than in the NHS, they may be tempted to work in the private sector. On the one hand, a private practice may offer more flexibility to increase working hours, but on the other hand individual patients in the private sector may demand more attention from their physician. Moreover, the NHS may guarantee a steady inflow of patients. And even if altruistic physicians can treat more patients in a private practice, this has to make up for a less favourable patient base.

By assuming a perfectly competitive private sector, homogeneous physician ability, and a sufficient total supply of physicians, making a profit in the private sector has been made impossible. If (some) physicians could earn profits in the private sector, for instance because of a scarce ability for providing high-quality treatment, then this would increase the attractiveness of the private sector. Still, a highly able physician who also cares about patient welfare faces a trade-off between the profits obtained by treating patients in a private practice and the intrinsically more rewarding treatment of patients in the NHS. Hence, the existence of a private health care sector need not

deprive the public sector of high-quality physicians.

A   Appendix

Proof of Proposition 1.   Suppose that all altruistic physicians work in the NHS. Given that condition (5) is satisfied, altruistic physicians optimally provide treatment quality q^A as implicitly defined by (4). Each NHS patient has probability $N/F(Y_M)P$ to receive treatment quality q^A. Otherwise, NHS patients receive quality $\bar{q}$. Private sector patients with income Y_i optimally buy treatment quality q_i^* from regular physicians, as implicitly defined by (6). Hence, the level of income at which patients are indifferent between NHS and private treatment, Y_M, is implicitly determined by the equality in the proposition. Lemma 1 implies that patients with income $Y_i < Y_M$ opt for treatment in the NHS and patients with income $Y_i > Y_M$ prefer treatment in the private sector.

Patients are being treated in both the NHS and the private sector if $Y_L < Y_M < Y_H$. The first inequality in the Proposition states that the poorest patient must prefer treatment in the NHS over treatment in the private sector even when $N = 0$. Similarly, the second inequality in the Proposition states that patients with income Y_H must prefer treatment in the private sector if all other patients are treated in the NHS.

Lastly, we have to proof that given this allocation of patients, altruistic physicians prefer to work in the NHS. Consider an individual altruistic physician choosing between the NHS and the private sector. Substituting optimal treatment quality q^A into (3) and using (1) gives the utility of an altruistic physician from working in the NHS:

$$Z^A = c(\bar{q}) - c(q^A) + \gamma[V(q^A) - V(\bar{q})] \tag{A1}$$

Alternatively, the altruistic physician can work in the private sector. When he offers a bundle of treatment quality q' and cost w', all private sector patients for whom it holds that this treatment bundle yields higher utility than treatment by a regular physician, $u[(1-\tau_m)Y_i - w', q'] > u[(1-$

$\tau_m)Y_i - c(q_i^*), q_i^*]$, will apply for treatment by the altruistic physician.[25] Here, we derive that even if the altruistic physician could provide his private sector patient with the optimal treatment bundle for this patient type, the altruistic physician prefers to treat a NHS patient rather than any patient in the private sector. Obviously, offering one or more treatment bundles which are optimal for certain patient types also attract other patient types, and to discourage some patients types from applying the altruistic physician may optimally distort treatment bundles. As this implies that treating a patient in the private sector brings about even lower expected utility for the altruistic physician than we derive below, the findings below are sufficient to proof that altruistic physicians indeed prefer to work in the NHS, as stated in the Proposition.

Providing treatment quality q_i' at cost w_i' to a patient with income $Y_i \in [Y_M, Y_H]$ yields utility:

$$Z^A = w_i' - c(q_i') + \gamma\{u[(1 - \tau_m)Y_i - w_i', q_i'] - u[(1 - \tau_m)Y_i - c(q_i^*), q_i^*]\} \quad (A2)$$

where we have used that the outside option of the patient is treatment by a regular physician in the private sector, yielding utility $u[(1 - \tau_m)Y_i - c(q_i^*), q_i^*]$. Maximising (A2) with respect to q_i' and w_i', subject to $u(y, q) \geq u^o$, gives first-order conditions:

$$-c_q(q_i') + \gamma V_q(q_i') = 0 \quad (A3)$$

$$1 - \gamma U_y[(1 - \tau_m)Y_i - w_i'] = 0 \quad (A4)$$

From (A3), it follows that the optimal treatment quality is independent of income. Moreover, the optimal quality is equal to the optimal quality provided by altruistic physicians in the NHS, q^A, as (A3) is identical to (4), the first-order condition for altruistic physicians' optimal treatment quality in the public sector. Substituting for the optimal treatment bundle a patient with income Y_i obtains from a regular physician and using (6), we find that

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[25] As all private sector patients not treated by an altruistic physician will be treated by a regular physician, they optimally apply for treatment by an altruistic physician when this gives higher utility than treatment by a regular physician, even if the probability to be matched to an altruistic physician is infinitesimal.

both first-order conditions imply that the altruistic physician improves his patient's utility when:

$$\gamma V_q(q_i^*) > c_q(q_i^*) \tag{A5}$$

If this inequality is violated, the altruistic physician would optimally offer the same treatment bundle to a patient with income Y_i as regular physicians. Otherwise, i.e. when γ is sufficiently high, the altruistic physician offers both higher treatment quality and lower treatment cost to a patient with income Y_i than regular physicians. Note that since q_i^* increases with income, condition (A5) is satisfied for smaller values of γ for patients with relatively low income than for patients with higher income.

Clearly, the altruistic physician prefers treating a NHS patient over providing the same treatment bundle as regular physicians to a patient in the private sector, as the latter does not yield altruistic utility. Comparing (5) to (A5), it is easily verifiable that for some levels of γ, the altruistic physician optimally refrains from improving the utility of any patient in the private sector but does improve the utility of NHS patients. By (9), $\bar{q} < q_i^*$ for all patients in the private sector. It follows that $c_q(q_i^*) \geq c_q(\bar{q})$ and concavity implies that $V_q(q_i^*) < V_q(\bar{q})$. Hence, for some values of γ condition (5) is satisfied, but condition (A5) is violated, implying that for these values of γ altruistic physicians prefer to work in the NHS.

Now suppose that γ is sufficiently high, such that (A5) is satisfied for at least some private sector patients. Again, treating a patient for whom condition (A5) is violated is less rewarding than treating a NHS patient. By (A3), (A5) is violated if a patient optimally buys treatment quality $q_i^* \geq q^A$ when treated by a regular physician. Consider any patient for whom condition (A5) is satisfied. We have to show that even if the altruistic physician could provide the optimal treatment bundle to his private sector patient, treating a patient in the NHS is more rewarding than treating any patient in the private sector. Subtracting (A2) with $q_i' = q^A$ from (A1) and using (1), this implies that we have to show that:

$$\gamma[V(q_i^*) - V(\bar{q})] > w_i' - c(\bar{q}) + \gamma\{U[(1-\tau_m)Y_i - w_i'] - U[(1-\tau_m)Y_i - c(q_i^*)]\} \tag{A6}$$

for all patients with income $Y_i \in [Y_M, Y_H]$ for whom condition (A5) is satisfied, where w'_i is given by (A4). From assumption 1 and by combining conditions (6), (A4), and (A5), we know that $0 \leq w'_i < c(q^*_i)$.

First, suppose that $w'_i = c(q^*_i)$. The last term on the right-hand side of (A6) vanishes, and the condition boils down to $\gamma[V(q^*_i) - V(\bar{q})] > c(q^*_i) - c(\bar{q})$. This is always satisfied, as if (A5) is fulfilled we have that $q^*_i < q^A$, and from (A3) we know that $\gamma V_q(q) > c_q(q)$ for any $q < q^A$. Altruistic physicians are willing to incur the cost of increasing treatment quality up to q^A. Second, suppose that $0 \leq w \leq c(\bar{q})$. It suffices to show that $V(q^*_i) - V(\bar{q}) > U[(1 - \tau_m)Y_i - w'_i] - U[(1 - \tau_m)Y_i - c(q^*_i)]$. From Figure 1, we know that private sector patients prefer treatment by a regular physician in the private sector over treatment by a regular physician in the NHS, $u[(1 - \tau_m)Y_i - c(q^*_i), q^*_i] > u[(1 - \tau_m)Y_i, \bar{q}]$ for all $Y_i \in [Y_M, Y_H]$, i.e. all private sector patients are willing to pay $c(q^*_i)$ for an increase in treatment quality from $\bar{q}$ to q^*_i. Using (1), this implies that condition (A6) is satisfied.

Lastly, suppose that $c(\bar{q}) < w'_i < c(q^*_i)$. Let q^w be the treatment quality provided by a regular physician in the private sector in exchange for w'_i, as given by $w'_i = c(q^w)$. From the two arguments of the previous paragraph, it follows from (A3) that $\gamma[V(q^w) - V(\bar{q})] > c(q^w) - c(\bar{q})$ as $q^w < q^A$ and that $\gamma[V(q^*_i) - V(q^w)] > \gamma\{U[(1 - \tau_m)Y_i - w'_i] - U[(1 - \tau_m)Y_i - c(q^*_i)]\}$ as private sector patients are willing to pay $c(q^*_i) - w'_i$ for an increase in treatment quality from q^w to q^*_i. Hence, for any w'_i condition (A6) is satisfied. This implies that even when the altruistic physician can provide the optimal treatment bundle to a private sector patient, treating a patient in the NHS yields higher utility than treating any patient in the private sector. Hence, all altruistic physicians optimally work in the NHS. ∎

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