

Public versus Private Health Care in a National Health Service

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Approx. 8250 words.

Abstract

This paper study the interplay between private and public health care in a National Health Service. We consider a two-stage game, where at stage one a Health Authority sets the public sector wage and a subsidy to (or tax on) private provision. At stage two physicians decide how much to work in the public and the private sector. We characterise different equilibria depending on the Health Authority's objectives, the physicians' job preferences, and the cost efficiency of private relative to public provision of health care. We find that the scope for a mixed health care system is limited when physicians are indifferent between working in the public and private sector. Competition between physicians triggers a shift from public provision towards private provision, and an increase in the total amount of health care provided. The endogenous nature of labour supply may have counter-intuitive effects. For example, a cost reduction in the private sector is followed by a higher wage in the public sector.

JEL Classification: I11, I18, J42, L33

Keywords: Health care; Mixed oligopoly; Physicians

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1 Introduction

Most health care systems involve a mixture of public and private provision. In a National Health Service (NHS), though, the role for private health care is quite different than in private (or mixed) health care systems along several dimensions (Besley and Gouveia, 1994). In particular, health care is mainly provided publicly and financed by general taxation rather than private insurance payments. Still there exists a private sector alongside the public one in most countries with a NHS. An important difference, though, is that patients receive public health care for free, while seeking private health care they often have to cover the costs of the medical treatment by themselves.

Another interesting feature of NHS systems is that a substantial share of the physicians tends to work in both sectors. For example, in the UK most private medical services are provided by physicians whose main commitment is to the NHS. The UK Monopolies and Merger Commission (1994) estimated that about 61% of the NHS consultants had significant private work. Similar observations can be made in Norway, Sweden, France, etc. In other words, there seems to be close links between the public and the private sector not only on the demand side but also on the supply side.

The purpose of this paper is to analyse the complex relationship between the public and the private sector in a National Health Service, emphasising the direct links between the two sectors. The analysis will focus on the following questions: How does the option for NHS physicians to provide private health care affect the public provision? In what way may physicians' job preferences matter? Could it be that such a system is potentially unstable because the private sector tends to drive out the public sector? How should the Health Authority set wages in the public sector, and should it tax or subsidise the private sector?

To analyse these questions, we consider a situation where there is a Health Authority (e.g. the Ministry of Health) that sets a public sector wage and a subsidy to (or tax on) private provision of health care. Based on the payments in the public and the private sector, and on their job preferences, physicians decide how much to work in either sector.

In the public sector physicians are on salary, while in the private sector they are self-employed and earn profits from their private practice. Irrespective of the payments, physicians may have some intrinsic preferences for working in a public hospital or at a private clinic, which may be related to non-pecuniary job characteristics in the two sectors (see e.g. Scott, 2001).

The physicians labour supply is decisive of the amount of public versus private health care that will be provided. Patients perceive public and private health care as, but prefers to taken care of by the public sector since this is free at the point of consumption. Patients not served by the public health care sector may instead demand private health care.

The Health Authority may influence the physicians labour supply via the public sector wage offered and possible support on the private sector. While a higher wage will encourage physicians to spend more time in a public hospital, a subsidy on the private health care provision will have the opposite effect. However, it also has the opportunity to tax the private sector to induce more public provision. We investigate in detail how the Health Authority's wage setting and support (or taxation) of private sector is influenced by physicians' endogenous supply of labour, the costs of providing private health care as well as the costs associated with distortionary taxation.

There are some obvious informational asymmetries in the health care market. A large part of the literature is therefore concerned with the implications of such informational asymmetries for the amount of health care and the quality of it.¹ For example, several studies raise the issue of how the reimbursement scheme affects the total supply of health care as well as the quality.² In this paper, though, we sidestep from some of the issues that have been investigated in detail in the literature. We apply a model that does not encompass private information, and we do not raise the issue how quality of care

¹See Frech (1996) for a discussion of issues in the health market in general, and Frech (1991) for a discussion of compensation schemes for physicians.

²Ellis and McGuire (1986, 1990) have considered how the reimbursement scheme affects the supply of health services, while Ma (1994) and Sharma (1998) have investigated how it affects quality as well as the incentives for reducing costs. For a survey of the literature, see Newhouse (1996) or Ennis (1998).

is affected by the structure of the health sector. This allows us to concentrate on the complex relationship between a public and a private health care market, where there are direct links between those two sectors on both the supply and the demand side.

In the literature there are few studies that examine the mix of private and public health care. One study that does, and is closely related to ours, is Rickman and McGuire (1999).³ Their modelling approach is distinctly different from ours in many respects, though. First, we let a physician's utility be determined by his/her total wage income in the public sector as well as his/her income from the private sector. In contrast, in Rickman and McGuire (1999) a physician's utility from public sector work is determined by the performance of his/her public hospital as well as from his patients' satisfaction. Second, we assume an increasing marginal disutility of work. The reason for this is that each physician may face a soft time constraint, finding it more and more costly to supply an extra hour of labour. In contrast, Rickman and McGuire (1999) assume a constant marginal disutility. In their setting, therefore, there are no direct links on the cost side between the two sectors. Third, we let the government act as a monopsonist in the labour market in the public health sector and the hospital then receives full-cost reimbursement. Although Rickman and McGuire (1999) have full-cost reimbursement in the public sector, they have no direct link between the costs associated with public health care and the physicians' revenue from such an activity. Finally, we assume strategic interaction between physicians, while Rickman and McGuire (1999), building on the model of Ellis and McGuire (1986), ignores the role of competition.

The paper is organised as follows. In Section 2 we discuss various modelling issues,

³There are other studies of the interplay between public and private health care. Barros and Martinez-Giralt (2000) analyse the rivalry between preferred providers and out-of-plan providers under different reimbursement rules. Jofre-Bonet (2000) deals with the interaction between public and private providers when consumers differ in their income levels. Marchand and Schroyen (2000) consider how different physician contracts affect the mixture of public and private health care. They use a setting with monopolistic competition between physicians and where the government takes distributional aspects into account.

such as the formulation of demand and supply and the nature of the rivalry between the physicians. In Section 3 we derive the physicians labour supply for given payments. In Section 4, we report results concerning the equilibrium outcomes in two separate cases. In the first one, the role of physicians' job preferences is analysed, while in the second case, we consider asymmetric (cost) efficiencies in providing care. Finally, in Section 5, we summarise our findings.

2 The model

Consider a health care system characterised by a National Health Service (NHS). In this system there is three types of agents; The Health Authority (e.g. Ministry of Health), the hospital-based physicians, and individuals in need for medical treatment (i.e. patients). The health authority is responsible for providing public health care, assumed to be free of charge for the patients at the point of consumption. Physicians decide to work in a public hospital and/or establish their own private practise. Since private health care is not included in the NHS, patients are charged a (full-cost) price if they decide to visit a private practice. The demand for private health care is represented by the following inverse demand function:

$$p = 1 - Q_O - Q_P, \tag{1}$$

where p is the marginal willingness to pay, Q_o is the quantity of health care provided by the public sector (o) and Q_p is the quantity of health care provided by the private sector (p). First, note from (1) that public and private health care are assumed to be perfect substitutes from the patients' perspective.⁴ Second, note that we assume efficient rationing. As the public sector provision of health care increases, the marginal willingness

⁴McAvinchey and Yannopoulos (1994) find in an empirical study that private and public health care are substitutes. In some cases one could argue that private health care is of higher quality than public health care, and in other cases vice versa. Since we consider a situation where physicians operate in both the private and the public sector, we find it reasonable to assume public and private health care as perfect substitutes.

to pay for private health care drops. Hence, the public sector has by assumption served those consumers with the highest willingness to pay for health care.^{5 6}

On the supply side, the important input to production is health personnel. Let us call them *physicians*. For ease of exposition, let us normalise input and output so that one unit of labour equals one unit of health care. Then Q_i denotes the units of labour used in sector i , where $i = o, p$. Since we focus on a specific health care product, it is plausible to assume that there is only a limited number of physicians qualified to supply the health care product in question in a specific area. In line with this, we simplify by assuming that there are only two physicians in the market, which may work in both the public and the private sector. Let q_i^k denote the labour supplied by physician k in sector i , where $k = 1, 2$. Total provision of health care in sector i is then given by $Q_i = \sum_k q_i^k$.

In the public sector, the physicians are on salary, earning the wage, w per unit of labour. In the private sector physicians are self-employed and earns the profit from their private practice. Private sector revenues are equal to the price p , and possibly a transfer r from the health authority, per unit of health care (and thereby per unit of labour) provided.

Spending time providing health care generates disutility for the physicians. We find it plausible to assume a convex disutility function: the longer a physician initially works,

⁵Although we have not explicitly modeled waiting cost, one may argue that it is included in an implicit manner. If there is excess demand at a price for public health care equal to zero, the waiting line consists of those neither served by public nor private health care providers. However, the deadweight loss we derive from the demand function would capture the loss associated with not being served. See Iversen (1997) for an explicit modeling of waiting costs.

⁶This formulation is chosen since it is consistent with a system where public health sector's priority depends on the seriousness of the disease. However, high willingness to pay may not only depend on the severity of the disease, but may also depend on the wealth at an individual's disposal. It is difficult to disentangle these two effects, so distributional concerns may point in another direction. This might be of large importance if the income distribution is very skewed. Since we are focusing only on efficiency, we should be cautious with the interpretation of our model in a situation where the income distribution is very skewed.

the greater disutility from a marginal labour increase.⁷ In line with this, we let the marginal disutility be influenced by a physician's *total* amount of labour in public and private sector.

However, it seems plausible as well to assume that a decision to work more in one of the sectors is influenced not only by total labour input, but also by how much she works in that particular sector initially. The more a person has worked in one sector, the higher marginal disutility in this particular sector. This reflects that physicians are not indifferent about where to work. In particular, they may have an intrinsic preference for working in both the public and the private sector.⁸ A disutility function that encompasses both elements in the marginal utility is the following:

$$G^k = \left(q_o^k\right)^2 + \left(q_p^k\right)^2 + \delta q_o^k q_p^k, \quad (2)$$

where $0 < \delta < 2$. The parameter δ measures the degree of substitutability between working in the public and the private sector for each physician.⁹ If $\delta \rightarrow 2$, the marginal disutility is determined by only the total amount of labour supplied. This corresponds to the case where physician k perceives working in a public hospital or at a private clinic as perfect substitutes. Contrary, if $\delta \rightarrow 0$, the marginal disutility is determined by only how much the physician works in either private or public sector initially, implying that the allocation of labour supply between the two sectors matters. This refers to the

⁷In our setting we consider physicians that work in both the public and private sector. The total amount of work can then be quite high, and each physician may face some restrictions on their labour supply: There are obviously physical limitations to how much each of them can work each day. Then it is natural to assume that each physician's total supply is approaching some kind of capacity constraint, and a convex disutility function captures such a case.

⁸This may be due to non-pecuniary factors like job characteristics. For instance, physicians may prefer to work in the public sector because of opportunities for research and specialising, meeting colleagues, access to medical facilities, etc. On the other hand, the private health care sector may be attractive because of, for instance, more autonomy due to being self-employed. See e.g. Scott (2001) for the relevance of this.

⁹Alternatively, we can think of δ as the fraction of physicians that are indifferent between working in the public and the private sector.

case where physicians perceives public and private provision as imperfect substitutes, for instance, due to some intrinsic preferences related to certain job characteristics, as mentioned above.

We now have the following utility function for physician k :¹⁰

$$\pi^k = wq_o^k + (p + r - c)q_p^k - G^k, \quad (3)$$

where c denotes the marginal cost of providing health care in the private sector. The total marginal cost in private health care is the sum of c and the marginal disutility. With a slight abuse of terminology, in the following we refer to c as the marginal cost of private health care.

A Health Authority (HA) is responsible for providing public health care. In line with this, we find it reasonable to assume that the HA has a monopsony role in the labour market for health care workers. In particular, we assume that the HA sets the wage in the public sector. In our model, we take this into account by allowing the health authority to set w , the wage in the public sector. In addition, it can choose either to pay a per unit subsidy ($r > 0$) or impose a per unit tax ($r < 0$) on private health care. The health authority is in principle concerned about consumer surplus, physician utility as well as any possible distortion in the economy generated by taxes. From (1) we can derive the following utility function for persons demanding this particular health care product:

$$U = Q_o + Q_p - \frac{(Q_o + Q_p)^2}{2}. \quad (4)$$

Public health care is by assumption provided at a price equal to zero for the patients. Then the cost of public health care, as well as any possible payments to the private

¹⁰Note that we assume that physicians are not taking into account any patient benefit from health care when they maximize their utility. This non-altruistic approach is in contrast to some of the received literature, for example Rickman and McGuire (1999), where the patient's benefit enters the physician's utility function in a direct way. In principle, though, it should be simple to encompass altruism in our model. For example, it could be added as a downward shift in the disutility function.

sector, is financed by distortionary taxes. The social welfare function is the following:

$$W = U - pQ_p + \beta \sum_{k=1}^2 \pi^k - (1 + \lambda)(wQ_o + rQ_p), \quad (5)$$

where $\beta = 0, 1$ and $\lambda \in (0, 1)$. The parameter λ represents the marginal cost of public funds and captures the tax distortion. The other parameter β reflects the view that a health authority may put a different, and often lower, weight on provider surplus relative to the patients' benefit of receiving health care.

Each physician determines her own labour supply in each sector. It is an open question whether the physicians coordinate their decisions or not. For example, could it be that the physicians coordinate their decisions in the private sector by establishing a joint private health care firm where both works? In theory, there are four possible situations. These are shown in Table 1 below.

In the situation called *competition* in Table 1, both physicians set their labour supply non-cooperatively. That would be the case where physician k maximises the utility function specified in (3), π^k , with respect to q_o^k and q_p^k . However, we know from theory that the players can jointly be better off in a collusive outcome. In such a case, the physicians would maximise joint utility, $\pi^1 + \pi^2$, with respect to the physicians' labour supply in both sectors: q_o^1, q_o^2, q_p^1 and q_p^2 . In this situation, denoted *perfect coordination* in Table 1, both physicians are expected to restrict their total supply of labour, thereby increasing the equilibrium price in the private sector. If each physician's discount factor is sufficiently high, we know that *perfect coordination* can be the equilibrium outcome in a repeated game.

Table 1: Coordination of labour supply?

		Private sector	
		Yes	No
Public Sector	Yes	Perfect coordination	Public coordination
	No	Private coordination	Competition

In the two remaining situations, public coordination and private coordination, the physicians coordinate their labour supply in only one sector. However, we find neither of those two situations plausible. If the physicians have coordinated their labour supply in one sector, why should they not extend the cooperation to also include the other sector and thereby be better off? Therefore, we find it reasonable to contrast *competition* with *perfect coordination*. From now on we denote the latter simply *coordination*. We let superscript S and F denote coordination and competition, respectively. Whether coordination would be the equilibrium outcome is determined by exogenous factors such as period length and time preference rate. In addition, we may expect the structure of the private sector to be of importance. In particular, whether antitrust enforcement allows physicians to establish joint facilities can be decisive for whether a competitive outcome is attained or not in the labour market.

The rules of the game are the following:

Stage 1: The government sets w and r .

Stage 2: The physicians set q_i^k , where $i = o, p$ and $k = 1, 2$.

The model is solved by backward induction.

3 Physicians' labour supply

Let us start the analysis by solving the game at stage two. In the *competition* game, physician k sets q_o^k and q_p^k to maximise (3), yielding the following first order conditions:¹¹

$$\frac{\partial \pi^k}{\partial q_o^k} = 0 \Leftrightarrow w - q_p^k = 2q_o^k + \delta q_p^k \quad (6)$$

$$\frac{\partial \pi^k}{\partial q_p^k} = 0 \Leftrightarrow 1 + r - (q_o^k + q_o^l) - 2q_p^k - q_p^l = c + 2q_p^k + \delta q_o^k, \quad (7)$$

where $k, l = 1, 2$ and $k \neq l$. The left-hand side of (6) and (7) represent the marginal revenues of providing public and private health care, respectively, while the right-hand sides are the corresponding marginal costs.

Notice the *crowding-out effect* the physician is facing when deciding her labour supply in the public and the private sector. When increasing the time spent at a public hospital, more patients are taken care of in the public sector, and this will, in turn, lower the demand for private health care. Thus, by restricting the labour supply in the public sector, the physician increases the profitability of working in the private sector. Solving stage 2 of the game, yields the following equilibrium outcomes:

$$q_o^F(w, r) = \frac{5w - (1 + r - c)(1 + \delta)}{8 - 3\delta - \delta^2} \quad (8)$$

$$q_p^F(w, r) = \frac{2(1 + r - c) - w(2 + \delta)}{8 - 3\delta - \delta^2}, \quad (9)$$

where the superscript F denotes that we consider the competition game.

In the *coordination* game, the physicians set q_o^1, q_o^2, q_p^1 and q_p^2 to maximise joint profit, $\pi^1 + \pi^2$, yielding the following first order conditions:¹²

$$\frac{\partial (\pi^1 + \pi^2)}{\partial q_o^k} = 0 \rightarrow w - (q_p^k + q_p^l) = 2q_o^k + \delta q_p^k \quad (10)$$

$$\frac{\partial (\pi^1 + \pi^2)}{\partial q_p^k} = 0 \rightarrow 1 + r - c - (q_o^k + q_o^l) - 2(q_p^k + q_p^l) = 2q_p^k + \delta q_o^k. \quad (11)$$

¹¹Second order conditions require that $\delta < -1 + 2\sqrt{2} \simeq 1.83$.

¹²Second order conditions require $\delta < -2 + 2\sqrt{3} \simeq 1.46$.

Again the left-hand side of (10) and (11) are the marginal revenues of providing public and private health care, respectively, and the right-hand sides are the corresponding marginal costs. While coordination eliminates the negative externality between physicians due to non-cooperatively labour supply present in the competition game, we see from the conditions that the crowding-out effect between public and private labour supply is also present in this case. Solving the first order conditions, yield the following outcomes at stage 2 of the game:

$$q_o^S(w, r) = \frac{6w - (1 + r - c)(2 + \delta)}{8 - 4\delta - \delta^2} \quad (12)$$

$$q_p^S(w, r) = \frac{2(1 + r - c) - w(2 + \delta)}{8 - 4\delta - \delta^2}, \quad (13)$$

where the superscript S denotes that we consider the coordination game.

As expected, physicians will work more in the public sector and less in the private sector when the wage (w) becomes higher, all else equal. The opposite is true when the Health Authority subsidise private health care provision ($r > 0$). We also see that the marginal cost of private provision (c) affects the physicians' allocation of working time. This is not true for any production costs in the public sector since these are covered by the Health Authority and do not enter the physicians' utility functions. Obviously, these effects are present irrespective of whether physicians compete or coordinate their labour supply.

The effect of physician preferences, measured by δ , on private versus public labour supply (for given w and r) is, however, more complicated. Examination of the equilibrium outcomes enables the following statement.

Proposition 1 *Let $j = F, S$.*

- (i) $q_o^j = 0$ and $q_p^j > 0$ if $w \leq \underline{w}^j$
- (ii) $q_o^j > 0$ and $q_p^j = 0$ if $w \geq \bar{w}^j$
- (iii) $\bar{w}^j - \underline{w}^j > 0$ and $\frac{\partial}{\partial \delta} (\bar{w}^j - \underline{w}^j) < 0$.

Proof. Consider the competition game ($j = F$). Setting (8) and (9) equal to zero and solving for w , yield the following critical values for public and private provision,

respectively,

$$\underline{w}^F = \frac{1 + \delta}{5} (1 + r - c),$$

$$\overline{w}^F = \frac{2}{2 + \delta} (1 + r - c),$$

where

$$\overline{w}^F - \underline{w}^F = \frac{(8 - 3\delta - \delta^2)}{5(2 + \delta)} (1 + r - c) > 0,$$

and

$$\frac{\partial}{\partial \delta} (\overline{w}^F - \underline{w}^F) = -\frac{14 + 4\delta + \delta^2}{5(2 + \delta)^2} (1 + r - c) < 0$$

In a similar way the results for the coordination game ($j = S$) can be proved. ■

When physicians have the ability to decide their labour supply in the public and the private sector, and this affects the number of patients treated in either sector, the amount of public and private health care provided depends crucially on the public sector wage relative to potential profits in the private sector. From the Lemma its clear that there is an upper and a lower bound on the wage that induce the physicians to work in both sectors. If the wage becomes sufficiently low, physicians decide to spend time only in the private sector, while if the wage becomes sufficiently high they decide to only work in the public sector.

Less evident, though, is the effect of physicians' job preferences (measured by δ) on private versus public provision of health care. From the Lemma we see that as physicians become more indifferent about where to work, the scope for a mixed health care system is reduced. The reason for this is two-fold: First, δ affects the *total amount of labour* physicians are willing to supply. When δ becomes higher, the cost of working an extra hour in either sector is increasing, and this tends to lower physicians' total labour supply for a given payment. Second, δ also affects the physicians' *division of labour* between the two sectors. When physicians have an intrinsic motivation for working in a public hospital or at a private clinic ($\delta \rightarrow 0$), this provides an incentive for the physicians to split their working time, irrespective of relative payments in the two sectors. On the

other hand, when physicians are indifferent between where to work ($\delta \rightarrow 2$), they tend to spend all their working hours in the sector which yields the higher payment.

4 The Health Authority

Having described the physicians incentives to work in the public and the private sector for given payments (w and r), we now turn to the HA's decision about the public sector wage and support to (or taxation of) private health care provision. We assume that the HA is either concerned about patients' welfare only, or both patients' and physicians' welfare. Two separate cases are analysed. In the first one, attention is restricted to physicians' job preferences and how this may influence the HA's wage setting and support to the private sector, and, in turn, the scope for public and private health care. In the second one, we will focus on asymmetric (cost) efficiency of providing health care, and examine how this may affect the desirability of public versus private health care. In either case, we also analyse how the nature of competition between physicians may alter HA's decisions.

4.1 Physicians' job preferences

Let us start by examining the role of physicians' job preferences. For simplicity, we assume that public and private provision are equally efficient, i.e. $c = 0$. Consider a HA that only cares about patients' welfare ($\beta = 0$). From (5), the HA solves the following problem

$$\max_{w,r} U - pQ_p - (1 + \lambda)(wQ_o + rQ_p),$$

anticipating the physicians' labour supply responses, which in the competition case is given by (8) and (9), and in the coordination case is given by (12) and (13). Note that when the HA does not care about providers' surplus, physicians' job preferences do not directly affect the HA's decisions, but only indirectly via the physicians' labour supply responses to different wages and subsidies. The equilibrium outcomes in both the competition and coordination game are presented in Table A in the Appendix.

Let us start by investigating how physicians' job preferences affects the scope for public and private provision of health care. From the equilibrium outcomes, we can establish the following result.

Proposition 2 *Assume that $c = 0$ and $\beta = 0$, and let $j = S, F$.*

- (i) $q_o^j > 0$ if $\delta < \delta_o^j(\lambda)$.
- (ii) $q_p^j > 0$ if $\delta < \delta_p^j(\lambda)$.
- (iii) $q_o^j > 0$ and $q_p^j > 0$ if $\delta < \min\{\delta_o^j(\lambda), \delta_p^j(\lambda)\}$

Proof. The results are found by setting the equilibrium values of q_o^j and q_p^j , reported in Table A in the Appendix, equal to zero and solve the expressions for δ , where $j = F, S$. We then get the following critical values for public provision

$$\delta_o^F(\lambda) = \frac{-3\lambda^2 + 4\lambda + 5}{2(\lambda^2 + 2\lambda + 1)} \text{ and } \delta_o^S(\lambda) \equiv \frac{-2\lambda^2 + 2\lambda + 3}{2\lambda + \lambda^2 + 1}$$

and for private provision

$$\delta_p^F(\lambda) \equiv 2\lambda + \frac{3}{2} \text{ and } \delta_p^S(\lambda) \equiv 2\lambda + 1,$$

in the competition case (F) and the coordination case (S), respectively. ■

Thus, the scope for public and private provision of health care depends crucially on physicians' job preferences (δ). Both public and private provision of health care requires that physicians' perceive working in the public and private sector as sufficiently imperfect substitutes (i.e. δ is sufficiently low). However, the relation to the marginal cost of public funds are different. While a high λ tends to reduce the scope for public provision of health care, the opposite is true for a low λ . The reason is, of course, that public provision is purely based on costly transfers from the Health Authority, while private provision is only partially so, given that ($r > 0$).

In Figure 1, we have characterised the different regimes that may emerge depending on physicians' job preferences (δ) and the marginal cost of public funds (λ) for the competition game. A similar picture is present for the coordination game. In this figure,

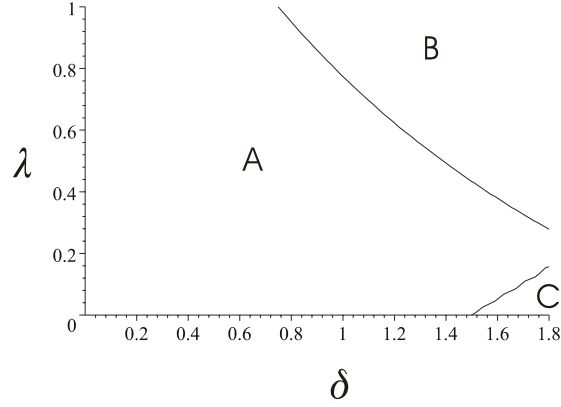


Figure 1: The scope for a mixed health care system when $j = F, c = 0$.

Regime A refers to a mixed health care system including both public and private health care provision, while Regime B refers to a purely private regime without any public provision, and Regime C refers to a purely public regime.

To fully understand the mechanisms at work let us consider how the public sector wage and the subsidy to the private sector are influenced by the physicians' job preferences. From the equilibrium outcomes in Table A in the Appendix, the following result can be established.

Proposition 3 *Assume that $c = 0$ and $\beta = 0$.*

- (i) $r^j < 0$, where $j = F, S$.
- (ii) $w^S > w^F$ if $\delta < \delta_w(\lambda)$, and $r^S < r^F$ if $\delta < \delta_r(\lambda)$

Proof. (i) By setting r^F and r^S (in Table A in the Appendix) equal to zero and then solve for δ we get:

$$\delta_r^F = \frac{-3 - 8\lambda - 4\lambda^2 + \sqrt{(49 + 200\lambda + 304\lambda^2 + 200\lambda^3 + 48\lambda^4)}}{2(\lambda^2 + 2\lambda + 1)},$$

$$\delta_r^S = \frac{-3 - 10\lambda - 5\lambda^2 + \sqrt{(121 + 532\lambda + 874\lambda^2 + 620\lambda^3 + 161\lambda^4)}}{2(2\lambda^2 + 4\lambda + 2)}.$$

Then it can be proved that $\delta_r^F \notin (0, -1 + 2\sqrt{2})$ (see footnote 12) and $\delta_r^S \notin (0, -2 + 2\sqrt{3})$ (see footnote 13), which are the relevant values of δ in the competition game and the coordination game, respectively.

(ii) By setting $w^S = w^F$ and $r^S = r^F$, respectively, and solving for δ , we get the critical values $\delta_w(\lambda)$ and $\delta_r(\lambda)$, where both can be within the allowed set $(0, -2 + 2\sqrt{3})$ for given values of λ . ■

Thus, irrespective of whether physicians compete or coordinate their labour supply, the HA imposes a tax on their provision of private health care. To understand this result, remember the HA's objectives, which is to maximise patients' utility while take into account distortions due to costly public transfers. Although patients consider public and private health care as perfect substitutes, the fact that they have to pay the full bill in the private sector implies that they prefer to be taken care of by a public hospital, which tends to limit the scope for a private sector.

On the other hand, free public health care means that public provision relies fully on costly transfers from the HA, which tends to limit the scope for the public sector. In addition, the HA must take into account the physicians' labour market responses. This is especially the case when physicians are rather indifferent about where to work (a high δ). In this situation, they tend to spend all their time in the sector which yields the higher revenue, and this, together with the fiscal argument above, explains why the HA chooses to impose a tax on private health care provision.

The comparison of the coordination and the competition case (part (ii) of the Proposition) is illustrated in Figure 2. We see that as long as physicians are sufficiently interested in working in both sectors (δ is sufficiently low), they will face a higher wage in the public sector, but also a higher tax in the private sector, when they coordinate their labour supply rather than compete. This refers to regime A in the figure. The reason is intuitive. Coordination of labour supply has two effects. First, it tends to restrict the total amount of time spent in providing care. Second, it tends to increase the profit potential in the private sector. To secure an optimal level of public health care the HA,

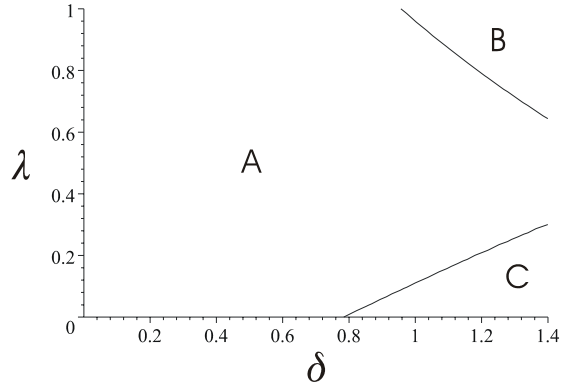


Figure 2: Comparison of wages and subsidies in the competition and coordination game for $c = 0, \beta = 0$.

therefore, must set a higher wage and a higher tax on private provision to induce the physicians to reallocate their labour supply.

On the other hand, if physicians become sufficiently indifferent between where to work two things may happen. First, if the marginal cost of public funds (λ) is high, this limits the HA's ability to set high wages to attract physicians to the public sector. However, this makes it more tractable for the HA to tax physicians in order to reduce the profitability of working in the private sector, which explains why $w^S < w^F$ (and $r^S < r^F$) is true in this situation. In regime C, where the marginal cost of public funds is low, the opposite is true, implying that $r^S > r^F$ (and $w^S > w^F$). This demonstrates that taxation may work as a regulatory substitute for public sector wage in provision of health care.

4.2 Asymmetric cost efficiency

The results above were derived under the assumption that the public and the private sector were equally (cost) efficient in producing health care. In practice, this may not always be the case. In health care systems characterised as NHS, public hospitals may

have access to inputs, like medical equipment, pharmaceuticals, etc., at lower prices than private clinics, for instance, because they are larger buyers. In this section we will therefore assume a positive marginal cost in the private sector ($c > 0$), while the marginal cost in the public sector is normalised to zero.¹³ To focus on the effect of asymmetric cost, we will abstract from the issue of physicians' job preferences. For simplicity, we assume that $\delta = 1$, which means that the public and private sector is considered as imperfect substitutes by the physicians. Moreover, we restrict attention to a HA that is concerned about both patients' and physicians' welfare ($\beta = 1$). This is not crucial for the analysis as the results are not qualitatively altered for the other case.

From (5), the HA solves the following problem:

$$\max_{w,r} W = U - pQ_p + \sum_k \pi^k - (1 + \lambda)(wQ_o + rQ_p),$$

anticipating the physicians' labour supply responses, which are given by (8) and (9) for the competition game and (12) and (13) for the coordination game. The equilibrium outcomes in are shown in Table C in the Appendix.

Proposition 4 *Assume that $\delta = 1$. Then*

- (i) $q_o^j > 0$ and $q_p^j > 0$ if $c \in (\underline{c}^j, \bar{c}^j)$, where $j = F, S$.
- (ii) $\bar{c}^F > \bar{c}^S$, and $\underline{c}^F > \underline{c}^S$.
- (iii) $\frac{\partial \bar{c}^j}{\partial \lambda} > 0$, and $\frac{\partial \underline{c}^j}{\partial \lambda} > 0$, where $j = F, S$.

Proof. \bar{c}^S (or \underline{c}^S) is found by setting the equilibrium value of q_p^S (or q_o^S) in the coordination regime (see Table C) equal to zero and solve with respect to c , yielding the following critical values

$$\bar{c}^S \equiv \frac{1 + 2\lambda + 4\lambda^2}{4(1 + 2\lambda + \lambda^2)} \text{ and } \underline{c}^S \equiv \frac{-1 - 3\lambda + 6\lambda^2}{3(1 + 3\lambda + 2\lambda^2)}$$

In a similar way, we find

$$\bar{c}^F \equiv \frac{1 + 3\lambda + 4\lambda^2}{4(1 + 2\lambda + \lambda^2)} \text{ and } \underline{c}^F \equiv \frac{-1 - 3\lambda + 6\lambda^2}{3(1 + 3\lambda + 2\lambda^2)},$$

¹³One can interpret a negative c as the private sector being more efficient than the public sector in providing health care. However, this must be considered as an approximation.

in the competition game. It is easy to check that $\bar{c}^j > \underline{c}^j$, where $j = F, S$. From these expressions, we have that

$$\bar{c}^F - \bar{c}^S = \frac{\lambda}{4(1+\lambda)^2} > 0 \text{ and } \underline{c}^F - \underline{c}^S = \frac{2\lambda}{9 + 42\lambda + 63\lambda^2 + 30\lambda^3} > 0$$

A marginal change in λ has the following effect on the critical values:

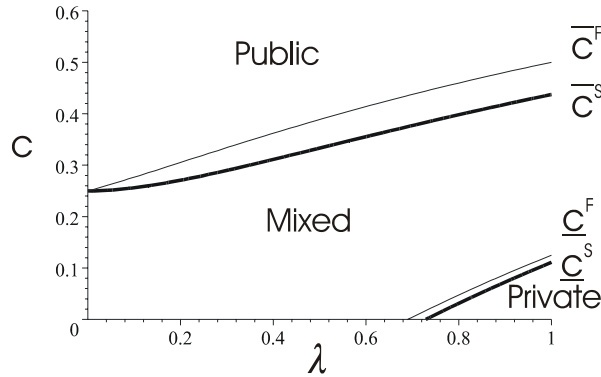
$$\frac{\partial \bar{c}^S}{\partial \lambda} = \frac{3\lambda}{2(1+\lambda)^3} > 0, \quad \frac{\partial \bar{c}^F}{\partial \lambda} = \frac{1+5\lambda}{4(1+\lambda)^3} > 0,$$

$$\frac{\partial \underline{c}^S}{\partial \lambda} = \frac{(2+3\lambda)8\lambda}{3(1+\lambda)^2(1+2\lambda)^2} > 0, \quad \frac{\partial \underline{c}^F}{\partial \lambda} = \frac{2(1+20\lambda+25\lambda^2)}{(1+\lambda)^2(3+5\lambda)^2} > 0.$$

■

The proposition shows that there is no interior solution if marginal costs in the private sector are either too high or too low. When c is sufficiently low only private provision of health care is an equilibrium, while the opposite is true when c is sufficiently high. The reason is intuitive. Consider the case of a low c . On one hand, a low c makes private provision less undesirable since it is both more efficient and yields lower prices, which both tend to increase the scope for private provision. On the other hand, a low c induces the physicians to work more in the private sector because they earn higher profits relative to the case of a high c . Thus, when c is low the HA must offer a high wage (or impose a substantial tax) to mitigate physicians' incentives to reallocate their labour supply towards the private sector.

Moreover, we see from (iv) that an increase in the marginal cost of public funds (λ) will reduce the scope for the public sector. The reason is obvious. By allowing the private sector to provide relatively more health care, and not subsidising private health care (see below), the HA can avoid serious distortions caused by taxation.



Public and private health care when $\delta = 1$ and $\beta = 1$.

In Figure 3, we have shown the upper and lower bounds on c depending on the marginal cost of public fund in both the competition and the coordination case. From the figure (and result (ii) in the Proposition) we see that the critical values of c are higher when physicians compete rather than coordinate their labour supply, which means that there is less scope for public provision in this case. To understand this, note the trade-off the HA is facing. On one hand, free health care by the public sector typically leads to a smaller price distortion than what is the case with private health care. This is the case if the price-cost margin in the private sector is larger than the (negative) price-cost margin in the public sector. If so, public health care leads to a lower deadweight loss.

On the other hand, free public health care incur costs associated with distortionary taxation, a cost that is not present in a private sector. The higher the wage paid to physicians, and thereby the larger capacity in the public sector, the higher is the cost associated with distortionary taxation. If physicians compete, labour supply in the private sector will increase and the deadweight loss will be reduced. Thus, it is no surprise then that competition between physicians results in a greater scope for the private sector to provide health care. This result suggests that an increase in the number of physicians would lead to a greater scope for the private provision of health care. The intuition is that a larger number of physicians would result in a lower price-cost margin in the private sector, and therefore less concern for deadweight loss in the private sector.

Proposition 5 Assume that $\delta = 1$ and $c \in (\underline{c}^j, \bar{c}^j)$, where $j = F, S$.

(i) $\frac{\partial w^S}{\partial c} < 0$, and $\frac{\partial w^F}{\partial c} < 0$ if $\lambda < 1$.

(ii) $\frac{\partial r^S}{\partial c} < (\geq) 0$ if $\lambda < (\geq) \frac{\sqrt{241}-7}{12} \simeq 0.71$, and $\frac{\partial r^F}{\partial c} > 0$.

Proof. From the equilibrium values reported in Table X, we have the following effects of a marginal change in c on the wage:

$$\frac{\partial w^S}{\partial c} = -\frac{6(1+\lambda)}{7+28\lambda+12\lambda^2} \text{ and } \frac{\partial w^F}{\partial c} = -\frac{2(1-\lambda^2)}{(5+7\lambda)(1+3\lambda)},$$

and on the subsidy (or tax):

$$\frac{\partial r^S}{\partial c} = \frac{-8+7\lambda+6\lambda^2}{7+28\lambda+12\lambda^2} \text{ and } \frac{\partial r^F}{\partial c} = \frac{3+8\lambda+5\lambda^2}{(5+7\lambda)(1+3\lambda)}.$$

Then we can easily verify the results reported in the Proposition. ■

Intuitively, we would expect the HA to respond to a cost reduction in the private sector by lowering the public sector wage and increasing the support to the private sector. From the Proposition we see that this is true for the wage setting, while the picture is more complicated when it comes to the subsidy (or tax) of private health care provision.

Let us first consider the case where physicians coordinate labour supply. In this case, the HA increases the subsidy as a response to lower private sector costs, as we would *a priori* expect. However, this is only true as long as the tax distortions are sufficiently small. The reason for this is as follows. A lower c makes private provision more profitable, inducing the physicians to work more in the private sector, for a given payment. This means that the public transfers to the private sector increases, but they increase more when λ is high than if it is low, which explains why the HA responds by lowering the subsidy in this case.

In the competition case, the HA's response to a change in marginal costs in the private sector is distinctly different from the coordination regime. In particular, the HA responds by reducing its support to the private sector irrespective of the size of the tax distortions. The intuition is that a private sector cost reduction triggers more intense rivalry between the physicians, which leads to an increase the labour supply in the private

sector that is higher than in coordination regime. Then the HA does not need to trigger any further increase in the activity level by increasing the support to the private sector. In fact, the HA lowers its support to the private sector and increases the wage to dampen the reduction in activity in the public sector.

Proposition 6 *Assume that $\delta = 1$ and $c \in (\underline{c}^j, \bar{c}^j)$, where $j = F, S$.*

- (i) $r^S > 0$ if $c < \frac{-2+7\lambda+6\lambda^2}{-8+7\lambda+6\lambda^2}$, and $r^F > 0$ if $c < \frac{-1-2\lambda+5\lambda^2}{3+8\lambda+5\lambda^2}$.
- (ii) $w^S > w^F$ if $c < \frac{7+32\lambda+73\lambda^2+116\lambda^3+24\lambda^4}{2(14+71\lambda-118\lambda^2+73\lambda^3+12\lambda^4)}$.
- (iii) $r^S > r^F$ if $c < \frac{7+10\lambda+4\lambda^2+79\lambda^3+30\lambda^4}{28+117\lambda-198\lambda^2+139\lambda^3+30\lambda^4}$.

Proof. Setting r^S and r^F (reported in Table C) equal to zero, respectively, and then solve the expressions with respect to c , yields result (i). Result (ii) is found by setting $w^S = w^F$, and then solve for c . Then we have the critical value shown on the right-hand side of (ii), from now on labelled \hat{c} . It can be shown that $\frac{\partial(w^S-w^F)}{\partial c} < 0$, which implies that $w^S > w^F$ for any $c < \hat{c}$. Furthermore, it can be shown that $\hat{c} < \bar{c}^S$ if $\lambda < 1$. In a similar way, we can prove (iii). ■

From the Proposition we see that the HA subsidises (taxes) private health care if the marginal cost of private provision (c) is sufficiently low (high). The reason is that the HA is concerned about the total surplus in society, and encourages private health care only if it is sufficiently cost efficient relative to public provision. Since public support is raised through distortionary taxation, the decision of whether to subsidise (or tax) the private sector depends also on the size of the loss due to tax collection.

We see from parts (ii) and (iii) in the proposition that coordination between physicians involves a higher wage and a higher subsidy (or lower tax) than if they compete, given that the marginal cost of private provision is sufficiently low. The intuition is that labour supply is lower when the physicians coordinate their activities, inducing the HA to encourage them to work more in both sectors by raising the wage and the support to the private sector. However, for sufficiently high costs in the private sector this result may be reversed, and both wages and support for the private sector may be lower in the coordination regime than in the competitive regime. The reason is, as explained

above, that a cost increase has a distinctly different effect on the labour supply in the two regimes. It dampens the rivalry between the physicians in the competitive regime, and the HA responds by increasing its support to the private sector. In the coordination regime, on the other hand, the HA responds by reducing its support to the private sector, or increasing support by a lower amount than in the competitive regime. This has, in turn, implications for the wage setting.

5 Concluding remarks

The purpose of this article has been to investigate public policy in mixed health care systems with close links between the private and the public health care sector on both the demand and the supply side. Although the model is stylised, many of our results are ambiguous. For example, (i) the public health care sector can either be driven out of the market or not, and (ii) private health care can be either taxed or subsidized. Ambiguity in a stylised model implies that we will also have to report ambiguous results in a generalized version of our model. This fact suggests that the model should not be used to predict some clear-cut results or to make clear-cut policy recommendations, but rather to point out some mechanisms that may be of importance in mixed health care systems.

First, we have pointed to a fundamental problem that may arise when physicians are allowed to earn revenues from private health care in addition to wage income from public health care. Physicians can increase the demand for private health care by restricting their supply of labour in the public health sector. The outcome in terms of health care system depends crucially on the physicians job preferences. When physicians are close to being indifferent between work in the public and private sectors, the scope for a mixed health care system tends to be very limited.

Second, the endogenous nature of labour supply complicates public policy. In some cases results are in line with what we expect. For example, the HA supports the private sector if the cost of private health care is sufficiently low. In other cases, though, it is not

that straightforward. For example, consider the case of a more efficient private sector. This triggers a shift of labour supply from public to private health care. Then it is not obvious whether the government should respond by increasing or reducing the wage in the public sector. The latter may apparently be the right choice. But we find in our setting that in some cases it should respond to a cost reduction in the private sector by increasing the public wage, thereby dampening the shift of labour supply from the public to the private sector.

Third, we show that the nature of the rivalry between the physicians may be important for public policy. In our setting, physicians can either coordinate their labour supply or compete on labour supply. Unsurprisingly, we find that competition between physicians results in an increase in private health care production and a reduction in public health care production. In our model the first effect dominates, so that competition between physicians leads to an increase in total production in the health sector. Less obvious, though, is the effect of a cost reduction in the private sector. When physicians compete, this triggers more intense rivalry between them. Then the government may find it optimal to reduce support to the private health care sector in order to dampen the shift in labour supply from the public to the private sector. In the case of high costs in the private sector we find in our setting that both the public wage and the support to (taxation of) the private sector is higher (lower) if physicians compete than if they coordinate their labour supply.

6 Appendix

Table A: Equilibrium outcomes when $c = 0$ and $\beta = 0$.

	Competition (F)	Coordination (S)
W	$\frac{2\lambda\delta^2+2\delta^2+3\lambda\delta+3\delta-13-15\lambda+2\lambda^2}{4\lambda^2\delta^2+8\lambda\delta^2+4\delta^2+12\delta+12\lambda^2\delta+24\lambda\delta-74\lambda-39-31\lambda^2}$	$\frac{1}{2} \frac{\lambda\delta^2+\delta^2+3\delta+3\lambda\delta-8-10\lambda}{2\lambda\delta^2+\lambda^2\delta^2+\delta^2+4\lambda^2\delta+4\delta+8\lambda\delta-8\lambda^2-20\lambda-11}$
R	$-\frac{2\lambda^2\delta^2+4\lambda\delta^2+2\delta^2+5\lambda^2\delta+10\lambda\delta+3\delta-17\lambda^2-31\lambda-14}{4\lambda^2\delta^2+8\lambda\delta^2+4\delta^2+12\delta+12\lambda^2\delta+24\lambda\delta-74\lambda-39-31\lambda^2}$	$-\frac{1}{2} \frac{2\lambda\delta^2+\lambda^2\delta^2+\delta^2+4\lambda^2\delta+8\lambda\delta+3\delta-8\lambda^2-18\lambda-10}{2\lambda\delta^2+\lambda^2\delta^2+\delta^2+4\lambda^2\delta+4\delta+8\lambda\delta-8\lambda^2-20\lambda-11}$
Q_o	$2 \frac{2\lambda^2\delta+4\lambda\delta+2\delta-4\lambda-5+3\lambda^2}{4\lambda^2\delta^2+8\lambda\delta^2+4\delta^2+12\delta+12\lambda^2\delta+24\lambda\delta-74\lambda-39-31\lambda^2}$	$\frac{2\lambda\delta+\lambda^2\delta+\delta-2\lambda+2\lambda^2-3}{2\lambda\delta^2+\lambda^2\delta^2+\delta^2+4\lambda^2\delta+4\delta+8\lambda\delta-8\lambda^2-20\lambda-11}$
Q_p	$2 \frac{2\lambda\delta+2\delta-7\lambda-4\lambda^2-3}{4\lambda^2\delta^2+8\lambda\delta^2+4\delta^2+12\delta+12\lambda^2\delta+24\lambda\delta-74\lambda-39-31\lambda^2}$	$\frac{\lambda\delta+\delta-3\lambda-2\lambda^2-1}{2\lambda\delta^2+\lambda^2\delta^2+\delta^2+4\lambda^2\delta+4\delta+8\lambda\delta-8\lambda^2-20\lambda-11}$
P	$\frac{4\lambda^2\delta^2+8\lambda\delta^2+4\delta^2+12\lambda\delta+8\lambda^2\delta+4\delta-23-52\lambda-29\lambda^2}{4\lambda^2\delta^2+8\lambda\delta^2+4\delta^2+12\delta+12\lambda^2\delta+24\lambda\delta-74\lambda-39-31\lambda^2}$	$\frac{2\lambda\delta^2+\lambda^2\delta^2+\delta^2+2\delta+5\lambda\delta+3\lambda^2\delta-15\lambda-8\lambda^2-7}{2\lambda\delta^2+\lambda^2\delta^2+\delta^2+4\lambda^2\delta+4\delta+8\lambda\delta-8\lambda^2-20\lambda-11}$

Table B: Equilibrium outcomes when $\delta = 1$ and $\beta = 1$.

	Competition (F)	Coordination (S)
W	$2 \frac{2+5\lambda-C-\lambda^2+\lambda^2 C}{7+26\lambda+15\lambda^2}$	$\frac{5+12\lambda-6C-6\lambda C}{7+28\lambda+12\lambda^2}$
R	$\frac{-10\lambda^2+10\lambda^2 C-5\lambda+10\lambda C+1-4C}{7+26\lambda+15\lambda^2}$	$\frac{-6\lambda^2+6\lambda^2 C+7\lambda C-7\lambda-8C+2}{7+28\lambda+12\lambda^2}$
Q_o	$2 \frac{1+2\lambda+3C-5\lambda^2+5\lambda^2 C+8\lambda C}{7+26\lambda+15\lambda^2}$	$2 \frac{1+3\lambda-6\lambda^2+3C+9\lambda C+6\lambda^2 C}{7+28\lambda+12\lambda^2}$
Q_p	$-2 \frac{-1-3\lambda+4C-4\lambda^2+4\lambda^2 C+8\lambda C}{7+26\lambda+15\lambda^2}$	$2 \frac{1+2\lambda-4C-8\lambda C+4\lambda^2-4\lambda^2 C}{7+28\lambda+12\lambda^2}$
P	$\frac{3+16\lambda+17\lambda^2+2C-2\lambda^2 C}{7+26\lambda+15\lambda^2}$	$\frac{3+18\lambda+16\lambda^2+2C-2\lambda C-4\lambda^2 C}{7+28\lambda+12\lambda^2}$

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