WHERE ARE ALL THE PHYSICIANS?
PRIVATE VERSUS PUBLIC HEALTH CARE

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September 2000

JEL Classification: I11, I18, J42
Key words: Monopsony, Health care, Mixed oligopoly

Abstract:
The purpose of this paper is to examine the interplay between public and private health care. We consider a situation where public and private health care are perfect substitutes, and the government sets the wage in the public sector and the subsidy to (or taxation on) the private sector. Each physician decides how much to work in each of the sectors, and earns revenues from wage income in the public sector and patients’ payments in the private sector. We find that the scope for public health care is limited if each physician does not have a genuine interest in working in the public health sector. Competition between physicians triggers a shift in production from public to private health care, and an increase in total production. The production is higher in the public sector and lower in the private sector than in the first best outcome. The endogenous nature of labour supply may have counter-intuitive effects. For example, a cost reduction in private sector may lead to a higher wage in the public sector.

This article was partly written while Lars Sørgard was visiting the University of California Santa Barbara, whose hospitality is gratefully acknowledged. Sørgard also thanks the Norwegian Research Council and the U.S.-Norway Fulbright Foundation for Educational Exchange for travel grants. We are indebted to Jan Erik Askildsen, John Cairns, Lise Rochaix-Ranson, Fred Schoyen, and participants at the 21st Nordic Health Economists’ Study Group Meeting in Lund in August 2000.
1. INTRODUCTION

In many European countries we observe a mixture of public and private health care. There are often close links between these two sectors, both on the demand and the supply side. Patients not served by the public health care sector may instead demand private health care, while health personnel may have to decide how much to work in each sector. The purpose of this paper is to examine how the government should behave in a situation with such a complex interaction between public and private health care.

The government is by definition the sole supplier of public health care. In line with this we assume that the government can set the wage in that sector. In many countries, health personnel employed in the public sector are allowed to operate in the private health sector as well.¹ The government’s wage setting is therefore decisive not only for the health personnel’s decision how much to work, but also for its decision where to work. In addition, the government decides either to support or to tax private health care. It then faces a trade off when deciding whether to promote public health care or not. A public health care sector would lead to only a limited deadweight loss, because it provides health care at lower prices than the private health care sector. On the other hand, the cost of a public health sector is financed by distortionary taxes while the patient primarily finances private health care. We investigate in detail how the government’s wage setting and support (or taxation) of private sector is influenced by the health personnel’s endogenous supply of labour, the costs of providing private health care as well as the costs associated with distortionary taxation.

¹Rickman and McGuire (1999) provide numerous examples of mixed health care markets, for example in countries as England, France and Germany, where each physician is active in both the public and the private health care market.
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.\textsuperscript{2} For example, several studies raise the issue of how the reimbursement scheme affects the total supply of health care as well as the quality.\textsuperscript{3} 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 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).\textsuperscript{4} 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.


\textsuperscript{3}Ellis 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).

\textsuperscript{4}There 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 into account distributional aspects.
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, such as the formulation of demand and supply and the nature of the rivalry between the physicians. In Section 3 we report results concerning the equilibrium outcome, where the government sets the public wage and the subsidy for (or tax on) private health care while each physician decides where to work and how much. In Section 4 we contrast the equilibrium outcome with the first best outcome. Finally, in Section 5, we summarise our findings.

2. SOME PRELIMINARIES

Let us consider a sub-sector in the health sector. In particular, we consider the demand and supply of a particular health care product. On the supply side, the health care product
can be provided either by the public or by the private sector. The demand for the health care product is represented by the following inverse demand function:

\[ P = A - Q_o - Q_p. \]

(1) 

\( P \) is the marginal willingness to pay, \( Q_o \) is the quantity of health care provided by the public sector \((o)\) while \( Q_p \) is the quantity of health care provided by the private sector \((p)\).

First, note from (1) that public and private provision of this particular health care product are by assumption perfect substitutes.\(^5\) Second, note that we assume efficient rationing. When the public sector provides health care, the marginal willingness to pay for health care drops. Hence, the public sector has by assumption served those consumers with the highest willingness to pay for health care.\(^6\)

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

\(^5\)McAvinchey 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. As we will explain later on, we consider a situation where each physician operates in both private and public sector. Therefore, in our setting we find is plausible to assume that those two goods are perfect substitutes.

\(^6\)Although we have not explicitly modeled waiting cost, one may argue that it is included in an implicit manner. At a price for public health care equal to zero, there is excess demand. The waiting line then consists of those neither served by public nor private health care. 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.
there are only two physicians and both may work in both public and private sector. Let $q_i^k$ denote the labour supplied by physician $k$ in sector $i$, where $Q_i = \sum_{k=1}^{2} q_i^k$.

If a physician works in the public sector s/he earns $W$ per unit of labour, the wage paid in the public sector. If s/he works in the private sector s/he earns revenue from providing the health care product at a price $P$ and (possibly) a transfer $R$ from the government per unit of health care (and thereby per unit of labour). In addition, labour generates disutility.\(^7\) We find it plausible to assume a convex disutility function: the longer a physician initially works, the greater disutility from a marginal labour increase.\(^8\)

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 those two sectors is influenced not only by total labour input, but also by how much s/he works in that particular sector initially. The more a person has worked in one sector, the higher marginal disutility in this particular sector. In particular, it may be reasonable to assume that each physician has a genuine interest in being employed in the public sector.\(^9\) A disutility function that encompasses both elements in the marginal utility, the

\(^7\)Note 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.

\(^8\)In our setting we consider physicians that work in both public and private health care. 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.

\(^9\)In particular, a physician may gain from meeting colleagues in the public health sector. For example, s/he can learn more about new treatments for the specific health care problem in question. If such factors are encompassed in the disutility function (utility that reduces the disutility), then the disutility from a certain amount of work should be higher if all work was supplied in the private sector than if it was split between the private and the public health care. As it turns out (see Proposition 1), if only total work matters then we
total amount of labour and the amount of labour in each sector, is the following for physician $k$:

$$g^k = \frac{Y[(q^k_p)^2 + (q^k_o)^2] + (q^k_p + q^k_o)^2}{2} \quad \text{where } Y \geq 0$$

Note the role of the parameter $Y$. If $Y \to 0$, then the marginal disutility is determined by only the total amount of labour initially, and the latter effect we described above is not taken into account. Contrary, if $Y \to \infty$, then the marginal disutility is determined by only how much s/he works in either private or public sector initially, meaning that the allocation of labour supply between the two sectors matters.

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

$$\pi^k = Wq^k_o + (P + R - C)q^k_p - g^k$$

$C$ denotes the marginal cost of providing health care in the private sector.\(^{10}\) 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.

The government provides public health care. In line with this, it is plausible to assume that the government has a monopsony role in the public health care labour market. In our model we take this into account by allowing the government to set $W$, the wage in the public sector. In addition, the government can choose either to pay a per unit subsidy ($R$) or impose a per unit tax (negative $R$) on private health care. The government may observe only private sector activity. By using a disutility function where also the distribution of work between the sectors matters, then there is greater scope for both sectors being active.

\(^{10}\)Note that marginal cost of public provision is normalised to zero. However, the wage, $W$, together with the marginal disutility of working in the public sector may be considered as the marginal cost of public provision.
is in principle concerned about consumer surplus, profits as well as any possible distortion in the economy generated by taxes. From (1) we can derive the following utility function for the persons demanding this particular health care product:

\[ U = A(Q_o + Q_p) - \frac{(Q_o + Q_p)^2}{2} \]

The public health care product is by assumption provided at a price equal to zero for the consumers. Then the cost of public health care, as well as any possible payment \( R \) per unit health in the private sector, is financed by distortionary taxes. The welfare function is the following:

\[ S = U - PQ_p + \sum_{k=1}^{2} \pi^k - (1 + \lambda)(WQ_o + RQ_p) \]

The parameter \( \lambda \) captures the tax distortion, and by assumption \( \lambda > 0 \).

Each physician determines his/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 \( k \) maximizes the utility function specified in (3), \( \pi^k \), with respect to \( q^k_o \) and \( q^k_p \). 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 both physicians’ labour supply in both sectors: \( q^1_o, q^1_p, q^2_o, q^2_p \). This is denoted perfect coordination in Table
1, and 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?

<table>
<thead>
<tr>
<th>Public sector</th>
<th>Private sector</th>
</tr>
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<tbody>
<tr>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
</tr>
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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 is the equilibrium outcome is determined by exogenous factors such as period length and time preference rate. In addition, we may expect that the structure of the private sector is of importance. In particular, it is of importance whether the physicians are allowed to establish a joint private firm or not. Hence, any ban on joint private health care firms may 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 $i=0,p$ and $k=1,2$.

The model is solved by backward induction.

3. EQUILIBRIUM OUTCOMES

In principle, three types of health care systems are possible: a pure public health care system, a pure private health care system, and a mixed private and public health care system. Notice that in our set up the physicians are free to choose where to work, and the government has no genuine preference for a particular health care system. It is only concerned about social welfare. The analysis below will mainly focus on the mixed system, but let us first explore the scope for the public and private sector when the two systems are equally efficient, i.e., $C=0$. The equilibrium outcomes in both the coordination regime and the competitive regime are shown in Table A in the Appendix.

**Proposition 1:** Let us assume that $C=0$. 

(i) If competition, then \( q_o^k > 0 \) iff \( Y > Y^F = \frac{\lambda^2}{1 + 2\lambda} \) and \( q_p^k > 0 \) for all \( Y \geq 0 \).

(ii) If coordination, then \( q_o^k > 0 \) iff \( Y > Y^S = \frac{1 + 6\lambda}{1 + 2\lambda} \) and \( q_p^k > 0 \) for all \( Y \geq 0 \).

Proof: The result is found by setting the equilibrium values of \( q_o^k \) and \( q_p^k \) in both the coordination and competition regime (given in Table A in the Appendix) equal to zero. Then the expressions are solved with respect to \( Y \). QED.

Note from the Proposition that if the two sectors are equally efficient \((C=0)\), the physicians will always provide labour in the private sector. The scope for public health care depends on the disutility of working more in one of the sectors \((Y)\). If \( Y \) is sufficiently low, then the physicians provide no labour in the public sector. This is the case whether the physicians compete or coordinate their labour supply. Remember that when \( Y \to 0 \) each physician’s marginal disutility is determined only by the total amount of work and therefore independent of how much s/he works initially in the private and public sector, respectively. In addition, the cost of tax distortions \((\lambda)\) reduces the scope for public health care provision because public health care is financed by taxation while private health care is (mainly) financed through market prices.

To understand the result in the Proposition, note how a reduction in labour supply in the public sector has a distinctly different effect on a physician’s utility than is the case with a reduction in private sector labour supply. A physician’s reduction in public labour supply implies that some consumers are not being served in the public sector and instead are increasing the demand in the private sector. This increases the profit potential in
private sector which, in turn, the same physician benefits from since s/he works in both public and private sector.

The result in Proposition 1 points to the fundamental problem facing the public sector when allowing physicians to offer their services in private sector, in addition to offering their service in public sector. By allowing them to supply private health care, the supply of health care in the public sector can be seriously constrained. We find that this may be the case even if the government is allowed to attract physicians by setting a high wage in the public sector and to lower profits in the private sector by imposing taxes.

However, it may be unrealistic to assume that each physician is indifferent about where to work (a low \(Y\)). For example, a physician initially working only in the private sector may have a lower marginal disutility from work in the public than in the private sector. As argued earlier, a physician may have a genuine interest in meeting colleagues in the public health sector. Assuming \(Y > 0\) would introduce such a feature into the model. For a sufficiently large \(Y\), we have an equilibrium outcome where each physician supplies labour in both sectors. To simplify exposition, we normalise by setting \(Y = 1\) in the following. In addition, we relax the assumption that the two sectors are equally efficient. Note that a positive (negative) \(C\) means that the private sector is less (more) efficient than the public sector. The equilibrium outcomes in both the coordination regime and the competitive regime are shown in Table B in the Appendix.

**Proposition 2: Let us assume that \(Y=1\).**

(i) If coordination, then \(q_o^k > 0\) and \(q_p^k > 0\)
\[
\frac{C^s}{C} \equiv \frac{A(1+2\lambda+4\lambda^2)}{4(1+2\lambda+\lambda^2)} > C > \frac{A(-1-3\lambda+6\lambda^2)}{3(1+3\lambda+2\lambda^2)} \equiv \frac{C^s}{C}.
\]

(ii) If competition, then \(q^k_0 > 0\) and \(q^k_p > 0\) if

\[
\frac{C^F}{C} \equiv \frac{A(1+3\lambda+4\lambda^2)}{4(1+2\lambda+\lambda^2)} > C > \frac{A(-1-2\lambda+5\lambda^2)}{3+8\lambda+5\lambda^2} \equiv \frac{C^F}{C}.
\]

(iii) \(\frac{C^F}{C} > \frac{C^s}{C}\), and \(\frac{C^F}{C} > \frac{C^s}{C}\).

(iv) \(\frac{\partial C^j}{\partial \lambda} > 0\), and \(\frac{\partial C^j}{\partial \lambda} > 0\), where \(j=S,F\).

Proof: \(\frac{C^s}{C} \) (or \(\frac{C^s}{C} \)) is found by setting the equilibrium value of \(q^k_0 \) (or \(q^k_p \)) in the coordination regime (see Table B) equal to zero and solve with respect to \(C\). In a similar way, we find \(\frac{C^F}{C} \) and \(\frac{C^F}{C} \) in the competitive regime. From these expressions, we have that:

\[
\frac{C^F}{C} - \frac{C^s}{C} = \frac{A\lambda}{4(1+\lambda)^2} \quad \text{and} \quad \frac{C^F}{C} - \frac{C^s}{C} = \frac{2A\lambda}{3(1+\lambda)(1+2\lambda)(3+5\lambda)}.
\]

A marginal change in \(\lambda\) has the following effect on the critical values:

\[
\frac{\partial C^s}{\partial \lambda} = \frac{3A\lambda}{2(1+\lambda)^3}, \quad \frac{\partial C^F}{\partial \lambda} = \frac{A(1+5\lambda)}{4(1+\lambda)^3}, \quad \frac{\partial C^s}{\partial \lambda} = \frac{A(2+3\lambda)8\lambda}{3(1+\lambda)^2(1+2\lambda)^2} \quad \text{and}
\]

\[
\frac{\partial C^F}{\partial \lambda} = \frac{2A(1+20\lambda+25\lambda^2)}{(1+\lambda)^2(3+5\lambda)^2}. \quad \text{QED.}
\]

The proposition shows – in line with our result in Proposition 1 – that there is no interior solution if marginal costs in the private sector are either too high or too low. For a
sufficiently low marginal cost, the physicians decide to work only in the private sector. Note that the government has the choice to set wages so high that it encourages the physicians to work in the public sector, but it chooses not to do so. For sufficiently high marginal costs in the private sector, the physicians work only in the public sector. In addition, we see from \( iv \) that an increase in tax distortions would reduce the scope for the public sector. The reason is obvious. By allowing the private sector to provide all health care and not subsidising private health care (see below), the government can avoid any serious distortion caused by taxation.

In Figure 1 we have shown an example of the upper and lower bounds on \( C \), and how the magnitude of the tax distortion affects these upper and lower bounds.

\[ \text{[Figure 1 approximately here]} \]

Note, both from Figure 1 and result \( iii \) in the Proposition, that the critical values of \( C \) are higher if there is competition rather than coordination between the physicians. This implies that there is less scope for public health care and more scope for private health care in the case of competition compared to coordination. To understand this, note the trade-off the government is facing. On the one hand, free health care by the public sector – or more precisely health care at a price equal to marginal costs – eliminates any deadweight loss. It will, however, incur costs associated with distortionary taxation. The higher the wage paid to physicians and thereby the larger capacity in the public health sector, the larger the costs associated with distortionary taxation. On the other hand, private health care eliminates the costs associated with taxation. But it will result in a
deadweight loss due to prices above marginal costs in the private health care sector. If physicians compete, labour supply in the private sector will increase and the deadweight loss will be reduced. No surprise, then, that competition between physicians results in greater scope for the private sector to provide health care.

**Proposition 3:** Let us assume that \( Y=1 \) and \( C^i < C < \bar{C}^i \), where \( i = F,S \).

(i) \( \frac{\partial W_S}{\partial C} < 0 \), and \( \frac{\partial W_F}{\partial C} < 0 \) if \( \lambda < 1 \).

(ii) \( \frac{\partial R_S}{\partial C} < 0 \) if \( \lambda < \frac{\sqrt{241}-7}{12} \approx 0.71 \), and \( \frac{\partial R_F}{\partial C} > 0 \).

Proof: From the equilibrium values reported in Table B, we have the following effect of a marginal change in \( C \):

\[
\frac{\partial W_S}{\partial C} = \frac{-(1+\lambda)6}{7+28\lambda+12\lambda^2}, \quad \frac{\partial W_F}{\partial C} = \frac{-(1-\lambda^2)2}{(5\lambda+7)(3\lambda+1)}, \quad \frac{\partial R_S}{\partial C} = \frac{-8+7\lambda+6\lambda^2}{7+28\lambda+12\lambda^2}, \quad \text{and}
\]

\[
\frac{\partial R_F}{\partial C} = \frac{3+8\lambda+5\lambda^2}{(5\lambda+7)(3\lambda+1)}
\]

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

Intuitively, we may expect that the government responds to a cost reduction in the private sector by lowering the wage in the public sector and increasing support for private health care and thereby reshuffling production from public to private sector. However, the picture is more complicated. All else equal, each physician responds to lower costs in the private sector by working more in the private sector and less in the public sector. The
government must take this into account, and this may lead to some counterintuitive results.

First, let us consider the case where physicians coordinate their supply of labour. As we would expect *a priori*, the government increases the support per unit of private health care supplied as a response to lower private sector costs. By doing so it encourages more private health care production, which has become less costly. The exception to this rule is when tax distortions are sufficiently large. In such a case the government is concerned about the increase in production in the private sector following a cost reduction, because such increased production results in more public support to private health care. Therefore, it responds to lower costs by reducing the support to private health care if tax distortions are sufficiently high. However, irrespective of the costs of taxation the government *increases* the public sector wage following a cost reduction in the private sector. This is a response to the shift in labour supply towards the private sector following a cost reduction in the private sector. By increasing the wage it dampens the reduction in public sector activity.

In the competitive regime, the government’s response to a change in marginal costs in the private sector is distinctly different from that described above for the coordination regime. In particular, the government responds by *reducing* its support to the private sector. The intuition is that the cost reduction in the private sector triggers more intense rivalry between the physicians, increasing the labour supply more in the private sector than is the case in the coordination regime. Then the government does not need to trigger any further increase in the activity level by increasing its support to the private sector. On the contrary, it lowers its support to the private sector to dampen the
reduction in activity in the public sector. In addition, it increases the public sector wage to further dampen the reduction in the activity in the public sector. The exception is when the cost of taxation high, then the government responds by lowering the wage and thereby lowering the costs of taxation.

**Proposition 4:** Let us assume that \( Y=1 \) and \( C^i < C < \bar{C}^i \), where \( i = F,S \).

(i) \( W^S > C \) if \( \lambda < \hat{\lambda}^S \in \left( \frac{1}{2}, \frac{3\sqrt{33}}{6} \right) \), and \( W^F > C \) if \( \lambda < \hat{\lambda}^F \in \left( \frac{3\sqrt{33}}{8}, \frac{2\sqrt{19}}{5} \right) \).

(ii) \( R^S > 0 \) if \( C < \frac{A(-2 + 7 \lambda + 6\lambda^2)}{-8 + 7 \lambda + 6\lambda^2} \), and \( R^F > 0 \) if \( C < \frac{A(-1 - 2 \lambda + 5\lambda^2)}{3 + 8 \lambda + 5\lambda^2} \).

(iii) \( W^S > W^F \) if \( C < \frac{A(7 + 32 \lambda + 73\lambda^2 + 116\lambda^3 + 24\lambda^4)}{2(1 + 71\lambda - 118\lambda^2 + 73\lambda^3 + 12\lambda^4)} \) or \( \lambda > 1 \).

(iv) \( R^S > R^F \) if \( C < \frac{A(7 + 10\lambda + 4\lambda^2 + 79\lambda^3 + 30\lambda^4)}{28 + 117\lambda - 198\lambda^2 + 139\lambda^3 + 30\lambda^4} \).

Proof: By inserting the expression for \( \bar{C}^S \) and \( C^S \) (reported in Proposition 2) into \( W^S \) (see Table B) we get \( W^S(\bar{C}^S) = \frac{A}{2(1 + \lambda)} \) and \( W^S(C^S) = \frac{A}{1 + 2\lambda} \). Comparison yields the following: \( W^S(\bar{C}^S) - \bar{C}^S = \frac{(1 - 4\lambda^2)A}{4(1 + 2\lambda + \lambda^2)} \) which is positive if \( \lambda < \frac{1}{2} \), and \( W^S(C^S) - C^S = \frac{(2 + 3\lambda - 3\lambda^2)2A}{3(1 + 3\lambda + 2\lambda^2)} \) which is positive if \( \lambda < \frac{3\sqrt{33}}{8} \cong 1.46 \). From Proposition 3 we know that \( \frac{\partial W^S}{\partial C} < 0 \). Then \( W^S > C \) for any \( C \in (C^S, \bar{C}^S) \) if \( \lambda < \hat{\lambda}^S \) where \( \hat{\lambda}^S \in \left( \frac{1}{2}, \frac{3\sqrt{33}}{6} \right) \). In a similar way, we can prove the remaining result in (i).
Setting \( R^S \) and \( R^F \) (reported in Table B) equal to zero, respectively, and then solve the expressions with respect to \( C \), yields result (ii).

From the expressions in Table B we set \( W^S = W^F \) and solve with respect to \( C \). Then we have the critical value shown on the right hand side in (iii), 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 \( C < \hat{C} \).

Furthermore, it can be shown that \( \hat{C} < \overline{C}^S \) if \( \lambda < 1 \). Then we have result (iii) in the Proposition. In a similar way, we can prove (iv). QED.

Note from Proposition 4 that the wage in public health care is set above marginal costs in the private sector except for cases with large costs associated with tax collection. Then the government sets a low wage to reduce the costs in the public sector and to redirect labour to the private sector where health care is financed by the consumers.

Note also that the government subsidises private health care if the marginal cost of private health care is sufficiently low, and it taxes private health care if it is sufficiently cost inefficient. The reason is that the government is concerned about the total surplus in society, and encourages private health care only if it is sufficiently cost efficient compared to public health care.

We see from parts (iii) and (iv) in the Proposition that when the costs are sufficiently low in the private sector, then the government sets a higher wage in the public sector and provides more support to the private sector in the coordination regime than in the competitive regime. The intuition is that the labour supply is lower when the physicians coordinate their activities, and the government encourages the physicians to
work harder in both sectors by increasing wages in public sector and support for 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, as shown in Proposition 3, the government responds to this by increasing its support to the private sector. In the coordination regime, on the other hand, the government responds by reducing its support to the private sector or increasing support by a lower amount than in the competitive regime. This also has, in turn, implications for wage setting.

**Proposition 5:** Let us assume that \( Y=1 \).

(i) \( Q_o^S > Q_o^F \) and \( Q_p^S < Q_p^F \).

(ii) \( Q_o^S + Q_p^S < Q_o^F + Q_p^F \) if \( \lambda < 1 \).

(iii) \( \frac{\partial Q_j^i}{\partial C} > 0 \), where \( j=S,F \).

(iv) \( \frac{\partial Q_j^i}{\partial C} < 0 \), where \( j=S,F \).

Proof: (i) We set \( Q_o^S = Q_o^F \) and solve with respect to \( C \):

\[
C = \frac{A(-5 - 18\lambda - 5\lambda^2 + 30\lambda^3)}{1 + 26\lambda + 55\lambda^2 + 30\lambda^3} \equiv C_q^i
\]
Then it can be shown that for $C > C^q_o$, then $Q^S_o > Q^F_o$. Furthermore, it can be shown that $C^q_o < C^S_o$. Hence, $Q^S_o > Q^F_o$ for all relevant values of $C$. In a similar way, we can prove the rest of part (i), and part (ii) of the Proposition.

Concerning (iii) and (iv), we have the following partial derivatives:

$$\frac{\partial Q^S_o}{\partial C} = \frac{6 + 18\lambda + 12\lambda^2}{7 + 28\lambda + 12\lambda^2}, \quad \frac{\partial Q^F_o}{\partial C} = \frac{6 + 16\lambda + 10\lambda^2}{(5\lambda + 7)(3\lambda + 1)}, \quad \frac{\partial Q^S_p}{\partial C} = \frac{-8 - 16\lambda - 8\lambda^2}{7 + 28\lambda + 12\lambda^2} \quad \text{and}$$

$$\frac{\partial Q^F_p}{\partial C} = \frac{-8 - 16\lambda - 8\lambda^2}{(5\lambda + 7)(3\lambda + 1)}.$$ Then the result in (iii) and (iv) can easily be verified. QED

We see from (i) that activity in the private sector is higher under the competitive regime than under the co-ordination regime. The reason is obvious. In the competitive regime the physicians compete for market shares in the private sector, and each of them provides a larger labour input in that sector. The reverse is true in the public sector, and it is an indirect effect of the behaviour in the private sector. In the competitive regime each physician supplies more labour in the private sector than is the case in the coordination regime, and compensates for this by supplying less labour in the public sector.

Note also that a competitive labour market results in larger total production in the health sector than is the case when the physicians’ labour supply is coordinated. This implies that in our model the increase in production in the private sector due to a shift from coordination to competition is not offset by the indirect, negative effect on production in the public sector.

As we already have suggested, a reduction in marginal costs in the private sector results in higher activity in the private sector and lower activity in the public sector. This
is no surprise. It shows that any countervailing effects of government wage setting and support for private health may dampen the initial effect, but it does not reverse the effect of a change in $C$ on labour input in each of these sectors.

4. FIRST BEST OUTCOME

Let us now consider this particular health care market from a social planner’s point of view. Ignoring any distributional issues, we focus on allocative efficiency by comparing the equilibrium outcomes of the two-stage game (reported in Table B) with the first best levels. Using the definition of the physicians’ utility function, given by (3), the social welfare function in (5) may be expressed as follows

$$S = U + \lambda P Q_p - (1 + \lambda) \left( C Q_p + \sum_{k=1}^{2} g^k \right) - \lambda \sum_{k=1}^{2} \pi^k$$

Note that costly government transfers due to tax distortions have the following implications: First, private health care improves social welfare because it reduces the need for costly government transfers. Second, the total social cost of producing health care is higher. Finally, leaving utility (or rent) to the physicians generates a welfare loss.

The social planner’s objective is to maximise social welfare, given by (6), with respect to the provision of health care in the private and public sectors ($Q_p$ and $Q_o$) subject to the restriction that each physician is willing to provide that optimal level (i.e. gets at least zero utility at the optimum). From (6) we see that leaving utility to the physicians reduces social welfare. Thus, in a first best world with access to lump-sum transfers, we can assume the participation constraints to hold with equality (i.e. $\pi^1 = \pi^2 = 0$). Then it is straightforward to derive the first best levels:
Let us now explore the scope for private and public provision of health care.

**Proposition 6:** Let us assume that $Y=1$.

(i) $Q^*_{o} > 0$ and $Q^*_{p} > 0$ if

$$C^* = \frac{A(1 + 2\lambda)}{2(2 + \lambda)} > C > \frac{A(3\lambda^2 - 1)}{3(1 + 2\lambda + \lambda^2)} = C^*.$$

(ii) $C^* > C^F > C^S$ and $C^* > C^F > C^S$.

(iii) $\frac{\partial Q^*_{o}}{\partial C} > 0$, $\frac{\partial Q^*_{o}}{\partial \lambda} < 0$, and $\frac{\partial Q^*_{o}}{\partial A} > (\leq) 0$ if $\lambda > (\leq) \sqrt[3]{13}.$

(iv) $\frac{\partial Q^*_{p}}{\partial C} < 0$, $\frac{\partial Q^*_{p}}{\partial \lambda} > 0$ and $\frac{\partial Q^*_{p}}{\partial A} > 0$.

Proof:

(i) $C^*$ (or $C^\dagger$) is found by setting the first best value of $Q^*_{o}$ (or $Q^*_{p}$) equal to zero and solve with respect to $C$. (ii) From proposition 2 we have the expressions for $C^F$, $C^S$, $C^F$ and $C^S$. By comparison with $C^*$ and $C^\dagger$, we have the result in the Proposition. Concerning (iii) and (iv), we have the following partial derivatives

$$\frac{\partial Q^*_{o}}{\partial C} = 6 \frac{1 + 2\lambda + \lambda^2}{7 + 14\lambda + 3\lambda^2}$$

$$\frac{\partial Q^*_{p}}{\partial C} = -4 \frac{2 + 3\lambda + \lambda^2}{7 + 14\lambda + 3\lambda^2}$$
Note from result \((ii)\) in the Proposition that the critical values of \(C\) are higher with first best outcome than with competition or coordination. This means, perhaps somewhat surprising, that there is less scope for public health care and more scope for private health care in a first best world compared to the other two cases. To understand this result, remember that private health care, both in the coordination regime and in the competition regime, resulted in a deadweight loss due to prices above marginal costs. This means that the physicians earn strictly positive profits in the private sector. However, in a first best world the government is able to extract all rent through lump sum transfers, which means that private health care provision becomes even more attractive for the government. Let us explore this further by comparing the first best levels with the equilibrium outcomes (reported in Table B). For simplicity, we assume the two sectors are equally efficient, \(i.e.,\) \(C = 0\).

**Proposition 7:** Let \(Y=1\) and \(C=0\), then \(Q_o^* > Q_o^F > Q_p^*\) and \(Q_p^* > Q_p^F > Q_p^S\)

Proof: Assuming \(C = 0\) yields the following first best and equilibrium outcomes.
Comparing these outcomes yields the following expressions

\[ Q_o^* - Q_o^F = -4A\frac{1 + 7\lambda^2 + 15\lambda^4}{(7 + 14\lambda + 3\lambda^2)(5\lambda + 7)(3\lambda + 1)} < 0 \]

\[ Q_o^F - Q_o^s = 2A\frac{-5 - 18\lambda + 5\lambda^2 + 30\lambda^4}{(7 + 28\lambda + 12\lambda^2)(5\lambda + 7)(3\lambda + 1)} < 0 \]

\[ Q_p^* - Q_p^F = 4A\frac{6 + 17\lambda + 16\lambda^2 + 9\lambda^4}{(7 + 14\lambda + 3\lambda^2)(5\lambda + 7)(3\lambda + 1)} > 0 \]

\[ Q_p^F - Q_p^s = 2A\frac{9 + 29\lambda + 14\lambda^2 - 12\lambda^4}{(7 + 28\lambda + 12\lambda^2)(5\lambda + 7)(3\lambda + 1)} > 0 \]

QED.

We see from the Proposition that in the case of identical efficiency in the two sectors, the public sector produces more and the private sector less than in the first best outcome. On the one hand, each physician does not take into account the cost of tax distortions when choosing their labour supply, which may lead to too high a labour supply in public sector. On the other hand, each physician does not take into account that part of the gain from reducing its supply in the private sector is a pure income distribution from consumers to physicians. This explains why each physician tends to supply less in the private sector than in the first best outcome. Since wage setting in the public sector and support to (or taxation of) the private sector are imperfect instruments, the government can only partly correct these distortions in the labour market.
We also see from the Proposition that competition between the physicians dampens the distortions in the labour market. As explained above, competition leads to more production in the private sector and less production in the public sector. Then both the tax distortion and the deadweight loss are dampened.

5. SOME CONCLUDING REMARKS

The purpose of this article has been to investigate public policy in a mixed health care sector, where there are close links between private and public health care on both the demand and the supply side. Although the model is highly stylized, we have pointed to some mechanisms that may be of importance in such a mixed health care market.

First, we have pointed to a fundamental problem that arises 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. In an example where each physician is close to being indifferent between work in the public and private sectors, we find that in equilibrium only the private sector provides health care. We find that this can be the case even if the government has the opportunity to set a high wage in the public sector to attract physicians and taxes private health care.

Second, the endogenous nature of labour supply complicates public policy. In some cases results are in line with what we expect. For example, the government sets a wage above marginal cost in the private sector if the tax distortion is sufficiently small and it supports private health care 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 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 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.

Fourth, we show that production is higher in the public sector and lower in the private sector than in the first best outcome. A shift in labour supply from the public to the private sector would reduce tax distortions as well as the deadweight loss. Competition between physicians is in that respect beneficial for society, since it would lead to a shift in labour supply towards the private sector.
REFERENCES


TABLE A: EQUILIBRIUM OUTCOMES WHEN $C=0$ AND $Y>0$

<table>
<thead>
<tr>
<th></th>
<th>Coordination</th>
<th>Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W$</td>
<td>$A \frac{Y^2(1 + 2\lambda) - Y^2(1 + 3\lambda) - 2\lambda}{Y^2(1 + 6\lambda + 4\lambda^2) - 16\lambda^2}$</td>
<td>$A \frac{Y^2(1 + 2\lambda) + Y^2(1 + 8\lambda - X^2) - 2\lambda}{Y^2[1 + 4\lambda + 4\lambda^2] + Y^2[6 + 22\lambda + 20\lambda^2] - 9\lambda^2}$</td>
</tr>
<tr>
<td>$R$</td>
<td>$A \frac{2Y^2(1 + 2\lambda) - 2Y^2(1 - 2\lambda - 6\lambda^2) + 2Y^2(1 - 4\lambda^2)}{Y^2(1 + 6\lambda + 4\lambda^2) - 16\lambda^2}$</td>
<td>$A \frac{2Y^2(1 + 2\lambda) - Y^2[1 - 4\lambda - 10\lambda^2] - 2\lambda^2}{Y^2[1 + 4\lambda + 4\lambda^2] + Y^2[6 + 22\lambda + 20\lambda^2] - 9\lambda^2}$</td>
</tr>
<tr>
<td>$Q_o$</td>
<td>$2A \frac{Y^2(1 + 2\lambda) - 2\lambda(6\lambda - 1)}{Y^2(1 + 6\lambda + 4\lambda^2) - 16\lambda^2}$</td>
<td>$2A \frac{Y^2(1 + 2\lambda) - 2\lambda}{Y^2[1 + 4\lambda + 4\lambda^2] + Y^2[6 + 22\lambda + 20\lambda^2] - 9\lambda^2}$</td>
</tr>
<tr>
<td>$Q_P$</td>
<td>$2A \frac{Y^2(1 + 2\lambda) + 2\lambda^2 - 2\lambda}{Y^2(1 + 6\lambda + 4\lambda^2) - 16\lambda^2}$</td>
<td>$2A \frac{Y^2[1 + 3\lambda + 2\lambda^2] + 2\lambda^2}{Y^2[1 + 4\lambda + 4\lambda^2] + Y^2[6 + 22\lambda + 20\lambda^2] - 9\lambda^2}$</td>
</tr>
</tbody>
</table>
### Table B: Equilibrium Outcomes When $C>0$ and $Y=1$

<table>
<thead>
<tr>
<th></th>
<th>Coordination ($S$)</th>
<th>Competition ($F$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W$</td>
<td>$\frac{(5 + 12\lambda)A - (1 + \lambda)6C}{7 + 28\lambda + 12\lambda^2}$</td>
<td>$\frac{2[(2 + 5\lambda)A - C - (A - C)\lambda^2]}{(5\lambda + 7)(3\lambda + 1)}$</td>
</tr>
<tr>
<td>$R$</td>
<td>$\frac{2(A - 4C) - (A - C)(7\lambda + 6\lambda^2)}{7 + 28\lambda + 12\lambda^2}$</td>
<td>$\frac{A - 4C - (A - 2C)5\lambda - (A - C)10\lambda^2}{(5\lambda + 7)(3\lambda + 1)}$</td>
</tr>
<tr>
<td>$Q_o$</td>
<td>$\frac{2(1 + 3\lambda)(A + 3C) - (A - C)12\lambda^2}{7 + 28\lambda + 12\lambda^2}$</td>
<td>$\frac{(1 + 2\lambda)2A + (3 + 8\lambda)2C - (A - C)10\lambda^2}{(5\lambda + 7)(3\lambda + 1)}$</td>
</tr>
<tr>
<td>$Q_p$</td>
<td>$\frac{(1 + 2\lambda)2A - (1 + 2\lambda)8C + (A - C)8\lambda^2}{7 + 28\lambda + 12\lambda^2}$</td>
<td>$\frac{(1 + 3\lambda)2A - (1 + 2\lambda)8C + (A - C)8\lambda^2}{(5\lambda + 7)(3\lambda + 1)}$</td>
</tr>
</tbody>
</table>
Figure 1: Upper and lower bounds of $C$, for $A = 1$. 