Prospective payment and patient selection: Case dumping*

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Abstract

Cost and quality consequences of health care payment schemes have been studied extensively, but relatively less attention has been paid on how payment schemes affect patient selection. Our objective is to examine the impact of prospective payment on patient selection. In particular, we are interested in the conditions under which prospective payment induces health care providers to treat patients in different health states differently. Dumping is the situation, in which the low-cost patients are treated but the high-cost patients are left untreated.

We use theoretical modeling techniques to explore the impact of exogenously determined prospective payment on treatment decisions. We examine the decision-making of a provider (a hospital or a physician), who decides whether or not to treat a patient. The patient can be in good or bad health states. The provider observes the health state and then makes the treatment decision. The patient is not aware of his health state but obtains additional information (in addition to prior probability distribution) through the treatment signal chosen by the provider. Having observed the treatment choice, patient decides whether or not to accept the treatment.

If the provider maximizes profit, the provider treats only the low-cost patient in the separating equilibrium of the model. Dumping is inefficient, if the patient in the bad health state obtains a higher net benefit from the treatment than the patient in the good health state. The extension of the model shows that if the provider is sufficiently altruistic, dumping does not take place in equilibrium.

1 Introduction

Selection refers to a situation in which either consumers or producers exploit unpriced heterogeneity and break pooling arrangements in a market (Rotschild and Stiglitz, 1977, Newhouse, 1996). Selection has often undesired welfare consequences, because some consumers may not obtain the goods and services they would like to purchase.

Selection may take place on the demand or the supply side of the market (Newhouse, 2002). There is some empirical evidence that consumers select health insurance plans according to their risk of becoming ill (Glied, 2000). On the other hand, there is only weak evidence indicating that hospitals or physicians choose to treat patients on the grounds of profitability. Newhouse (1989) and Newhouse and Byrne (1988) report findings which are consistent with supply-side patient selection. They found that after the introduction of the US Prospective Payment System in 1984 substantial amount of patients with negative accounting profit shifted to hospitals of last resort. This finding is consistent with the claim that health care providers refuse to treat unprofitable high-cost patients, which has also been called dumping of unprofitable cases (Ellis, 1998 and Ma, 1994).

Eggleston (2000) examines risk selection behavior of health care providers by building on agency models developed by Ellis and McGuire (1986, 1990). Her model provides several predictions on risk selection behavior of providers. She predicts that the effort exerted to select good risks from the patient population is increasing in the proportion of high risks in the population, the amount of supply-side cost sharing, and the morbidity of high risk consumers. The model also predicts that high levels of provider altruism and capitation payment decrease patient selection.

We examine the relationship between prospective payment and patient selection in a model with explicit asymmetric information between a provider and a patient. The provider observes the patient's health state, which can be good or bad and is unknown to the patient during the provider-patient interaction. We are interested in conditions under which the provider's treatment decisions vary according to the patient's health state. Different treatment in different health states could refer to a situation in which the high-cost patient in the bad health state obtains the treatment and the low-cost patient in the good health state is left untreated. Dumping (equilibrium) is the situation, in which the provider treats low-cost patients and declines the treatment of high-cost patients (Ellis, 1998) (in equilibrium).

We first examine the model with profit-maximizing providers and show that the dumping equilibrium is the only separating equilibrium of the model. Examination of the social welfare shows that dumping is inefficient, if the net benefit obtained from the treatment is higher for the patient in the bad health state than for the patient in the good health state. The modified version of the model shows that, if the provider is sufficiently altruistic, dumping will not occur in the separating equilibrium of the model.

The rest of the article is organized as follows. The following section displays the basic model to be examined. In Section 3 we derive conditions for socially optimal treatment. Section 4 examines those conditions under which patient selection and equal treatment of patients takes place in a model equilibrium. In section 5 we extend the basic to consider an altruistic physician motivated also by the health utility of the patient. Section 6 concludes the article.

2 The model

We consider decision-making between two active players, a provider (player 1) and a patient (player 2), and the health care regulator selecting the compensation scheme of the provider. The provider can be a physician or a hospital. Choices of the health care regulator are assumed to be exogenously determined. We consider mainly tax-financed public provision of health care services.

The game that we analyze is displayed in the Appendix. Structure of the extensive form is similar to that examined by Myerson (1988, p. 40). The game begins when Nature randomly selects the health state of the patient. The health state of the patient, denoted generically as h, can be good g or bad b with $0 \leq b < g < 1$. The probability that the health state is good is π. After the health state of the patient has been realized, the provider observes the patient's health state. If the provider needs to carry out costly diagnosis to observe the health state, such costs are assumed to be covered by an exogenous provider fee. We assume throughout the article that the patient does not know his health state but is aware of the prior probability distribution $(\pi, 1-\pi)$ of health states (g, b). Moreover, the patient obtains additional information about the health distribution from the treatment choice of the provider.

In the two information sets $I_1^1 = \{x\}$ and $I_2^1 = \{y\}$ the provider faces the set of actions $T = \{0, 1\}$ with generic element t.The choice $t = 1$ ($t = 0$) means that the patient in health state $h \in \{g, b\}$ is treated (is not treated). If the patient is not treated, the interaction between the provider and the patient ends, and the patient obtains utility from the current health state subtracted by the provider payment ϕ.

If the provider chooses to offer the treatment, the patient is allowed to choose. The patient observes whether or not the treatment is offered but still does not know his own health state. In the information set $I^2 = \{z, w\}$[1] the patient faces the set of actions $A = \{0, 1\}$ with generic element a. The choice $a = 1$ ($a = 0$) means that the patient accepts (does not accept) the treatment offered by the physician. If the patient accepts the treatment, the patient is treated, recovered, and pays for the treatment (through increased tax payments). In addition to the fee, the provider is paid the prospective payment p.

If the patient does not accept the treatment, he obtains the same utility as if the provider declined the treatment. The provider obtains the fee but incurs the fixed cost due to organization of the treatment possibility. Such fixed cost may arise from various administrative activities, which are necessary before the patient is actually treated. Such activities could include booking and preparation of the operating room for example. We consider such fixed costs separate from any variable costs of carrying out the treatment, like salaries of the doctors and nurses and material costs.

We then define the vN-M utilities at the terminal nodes of the game. Given pure-strategies (t, a) of the provider and the patient, the patient at health state $h \in \{g, b\}$ receives utility

$$U_2(t, a; h) \equiv u(h) + (t \times a)\beta(h) - (1 + \lambda) (\phi + (t \times a)p), \qquad (1)$$

where $u(h)$ is the (monetary) utility from health state h. We assume that the patient is completely recovered after the treatment and obtains full health, which is normalized to one. The health benefit that the patient in health state h obtains from the treatment is therefore $\beta(h) \equiv u(1) - u(h)$. We assume throughout the article that $0 \leq u(b) < u(g) < u(1)$, where $0 \leq b < g < 1$.

[1]The game has four decision nodes x, y, z and w. Variable n denotes a decision node.

Direct implication of this assumption is $0 < \beta(g) < \beta(b)$; the health benefit of the patient in bad health state (henceforth also b-type patient) is higher than the health benefit of the patient in good health state (henceforth also g-type patient).

The provider fee is regulated. Additionally, the regulator pays the provider a prospective payment $p \geq 0$, if the treatment is offered and accepted by the patient. In this article we mainly consider tax-financed public provision of health care. Taxation may cause distortions; social cost of extra funds raised through taxation is measured by the parameter $\lambda \geq 0$. It is worth to mention that the special case $\lambda = 0$ could also be considered as the private provision of health care.

The terminal node utilities of the provider can be computed using the following utility function:

$$U_1(t, a; h) \equiv \phi - t \times f + (t \times a)[p - c(h)]. \tag{2}$$

It is assumed that the provider fee ϕ covers any monetary loss that may arise from the treatment and diagnostic costs. The cost of treating a patient in health state $h \in \{g, b\}$ is $c(h)$. We assume $0 \leq c(g) < c(b)$, and the b-type patient (henceforth also high-cost patient) is more costly to treat than the g-type patient (henceforth also low-cost patient). In addition to the treatment cost, the provider incurs a fixed cost $f > 0$, if the treatment is offered to the patient.

In what follows, we examine sequential equilibrium (Kreps and Wilson, 1982) points in pure strategies. Although we examine all types of equilibrium points, we have a particular interest in the separating equilibrium points, in which patients in different health states are treated differently. At this point, we allow both possibilities: i) the provider treats the patient in good health state and refuses to treat the patient in bad health state and, secondly, ii) the provider treats the patient in bad health state and does not treat the patient in the good health state.

An assessment is a pair (τ, σ) where $\tau \equiv \{(1 - \tau_1, \tau_1), (1 - \tau_2, \tau_2)\}$ describes the strategies of the provider in the two information sets I_1^1 and I_1^2. In particular, τ_s is the probability that the provider assigns to treatment in the information set I_s^1. The behavior strategy σ defines the probability that the patient assigns to accepting the treatment in the information set I^2.

In the spirit of sequential equilibrium, we require the players strategies are sequentially rational and that beliefs can be consistently derived from strategies using the Bayes rule. The consistency requirement is also required in cases where the Bayes rule can not be applied because an information set I^2 is not reached with positive probability. The belief that patient assigns to decision node z is by the Bayes rule

$$Prob(n = z \mid I^2) \equiv \mu = \frac{\pi\tau_1}{\pi\tau_1 + (1-\pi)\tau_2}. \tag{3}$$

3 When is it socially optimal to treat a patient?

We first specify conditions under which society would like to see the patient treated. We adopt utilitarian approach to social welfare. This approach treats everyone equally and places no weights to utilities of the provider and the patient. The utilitarian social welfare function is defined as follows:

$$W(t,a;h) = U_1(t,a;h) + U_2(t,a;h) =$$
$$\phi - t \times f + (t \times a)\,[p - c(h)] + u(h) + (t \times a)\,\beta(h) - (1+\lambda)\,(\phi + (t \times a)p) =$$
$$u(h) + (t \times a)\beta(h) - \lambda(\phi + (t \times a)\,p) - (t \times a)c(h) - t \times f. \tag{4}$$

The outcome where the treatment is offered by the provider but not accepted by the patient is never an socially optimal outcome. The social welfare in that case is $W(1,0;h) = u(h) - \lambda\phi - f$. With positive fixed cost the social welfare $W(1,0;h)$ is always less than the social welfare in case the provider declines the treatment, ie. $W(0,a;h) = u(h) - \lambda\phi$. The obvious reason is the fixed cost: if the provider declines the treatment the fixed cost is saved, but if the patient refuses to be treated, the fixed cost must be paid (or is lost).

It is socially optimal to treat a patient in health state h, who is willing to accept the treatment, if

$$W(1,1;h) \geq W(0,a;h) \tag{5}$$

for both $a \in \{0,1\}$. The above condition (5) simplifies to

$$\beta(h) - \gamma(h) - \lambda p \geq 0, \tag{6}$$

where $\gamma(h) \equiv c(h) + f$ denotes the total cost of treatment. In words, it is socially optimal to offer treatment to a patient in health state h, if the net benefit from the treatment $\beta(h) - \gamma(h)$ exceeds the prospective payment p multiplied by the social cost of funding. If taxation causes no distortions, the patient in health state h should be treated, if the health benefit exceeds the total cost of treatment. Intuition of the standard cost-benefit comparisons changes only a little, when the social costs of financing public health care is included into the cost-benefit calculations.

Throughout the article we assume that net benefit from the treatment is strictly positive for both types of patients.

Assumption 1 $0 < \beta(h) - \gamma(h)$ for both $h \in \{g, b\}$.

One should observe that patient selection and even dumping of the b-type patients may be something valued by a utilitarian society and additional conditions are needed for dumping to be socially undesirable. Dumping is not desirable from the perspective of the society, if

$$0 < \beta(g) - \gamma(g) \leq \lambda p \leq \beta(b) - \gamma(b), \tag{7}$$

where the strict inequality comes from Assumpion 1. Under the condition (7), the b-type patient should be treated but the g-type patient should not be treated. The above condition also suggests that the necessary condition for dumping not to take place in the social optimum is that the net benefit of treating the b-type patient exceeds the net benefit of treating the g-type patient and $0 < \beta(g) - \gamma(g) < \beta(b) - \gamma(b)$. Now, depending on the value of λp, three outcomes are possible in the social optimum: a) both types of patients are treated, b) the b-type patient is treated and the g-type patient is not treated, and c) neither types are treated.

It is not immediately clear whether the net benefit from the treatment of the b-type patient exceeds that of the g-type patient. The net benefit (obtained from the treatment) of the b-type patient is higher than that of the g-type patient, if $\beta(b) - \gamma(b) > \beta(g) - \gamma(g)$. This inequality can be rearranged as follows:

$$1 > \frac{\gamma(b) - \gamma(g)}{\beta(b) - \beta(g)} \equiv ICBR_{bg}. \tag{8}$$

Hence, if the incremental cost-benefit ratio between b-type and g-type patients is less than one, then the net benefit of treating the b-type patient exceeds the net benefit of treating the g-type patient. In this case dumping never takes place in the social optimum.

4 Equilibrium analysis

In this section we examine pure-strategy equilibrium points of the game displayed in Section 2. We classify the analysis into two classes according to the way the patient is treated. Patient selection refers to the situation in which the provider treats g-type and b-type patients differently. In other words, in patient selection we are interested in the separating equilibrium points of the model. Equal treatment of patients, on the other hand, refers to the situation in which the provider treats g-type and b-type patients similarly. In this latter case our interest is on the pooling equilibrium points of the model.

4.1 Patient selection

In the model displayed in section 2, the provider is interested in the profit obtained from the treatment. This implies that in right circumstances the provider has an incentive to treat the g-type (low-cost) patient and leave the b-type (high-cost) patient untreated. We refer to such equilibrium behavior as dumping equilibrium (see Ellis, 1998, and Ma, 1994). In the pure-strategy dumping equilibrium $\tau_1 = 1,\ \tau_2 = 0$ and $\sigma = 1$. It is natural to require that the patient, and in particular the g-type patient, accepts the treatment in the dumping equilibrium. The next proposition examines the conditions under which dumping takes place under the prospective payment system. The proof the proposition can be found from Appendix.

Proposition 1 *Dumping takes place in equilibrium, if the prospective payment satisfies the conditions*

1. $c(g) + f < p < c(b) + f$ *and*

2. $p < \beta(g)/(1+\lambda)$.

Dumping equilibrium exists only if $\beta(g) > (1+\lambda)\gamma(g)$.

Conditions for dumping equilibrium are intuitive. The first condition creates the provider an economic incentive to treat the g-type patient and decline the treatment of the b-type patient. The second condition gives the patient, who is fully informed about his health state in equilibrium, an incentive to accept the offered treatment. Finally, health benefit of the g-type patient must exceed the cost of treating the g-type patient by a sufficient amount for dumping equilibrium to exist.

It is worth asking whether dumping is also desirable from the societal perspective. Analysis of Section 3 suggested that equilibrium dumping is inefficient, if the incremental cost-benefit ratio $ICBR_{bg}$ is strictly less than one. Under this condition, the net benefit obtained from the treatment of the b-type patient exceeds that of the g-type patient and dumping is not valued by society. Three possible outcomes may now take place in the social optimum: either both types of patients should or should not be treated or only the b-type of patient should be treated.

The dumping equilibrium is the only possible separating equilibrium of the model. To see why this holds true, let us assume that there is an equilibrium in which the b-type patient is treated and the g-type patient is not treated in equilibrium. Then it must hold true that

$$\phi - f + \sigma(p - c(g)) < \phi < \phi - f + \sigma(p - c(b)) \tag{9}$$

and the physician prefers to offer treatment in the information set I_2^1 and not to offer treatment in the information set I_1^1. The second inequality in (9) can not hold, if $p \leq c(b)$, and hence it must hold true that $p > c(b)$ for this type of equilibrium to exist. But then $p - c(g) > p - c(b) > 0$, and the above condition (9) can not be satisfied for any strategy of the patient.

4.2 Equal treatment of patients

We then examine equilibrium points with equal treatment of g-type and b-type patients. We first concentrate on equilibrium points in which the provider chooses to treat both types of patients and the patient accepts the treatment. The proof of the proposition can be found from Appendix.

Proposition 2 *The provider treats both g-type and b-type patients and the patient accepts the treatment, if*

1. $c(g) + f < c(b) + f < p$, *and*

2. $p < [\pi\beta(g) + (1 - \pi)\beta(b)]/(1 + \lambda)$.

Equilibrium exists if $\pi\beta(g) + (1 - \pi)\beta(b) > (1 + \lambda)\gamma(b)$.

According to Proposition 2, sufficiently high prospective payment induces the provider to offer treatment to both types of patients. Such treatment decisions provide no additional information about the health state of the patient, and the patient assesses the likelihood of being in the good health state using the prior probability distribution. When the second condition of Proposition 2 holds true, the patient is better off accepting the treatment than refusing it.

The second pooling equilibrium is the one in which neither high-cost nor low-cost patient is treated.

Proposition 3 *The provider declines the treatment in both b-type and g-type patients, if*

1. *The patient does not accept the treatment in equilibrium, or*

2. *The patient accepts the treatment in equilibrium and* $p < c(g) + f < c(b) + f$.

5 Altruism and patient selection

We then consider a provider who is not motivated purely by profit obtained from the treatment but also by health utility that the treatment provides to the patient. Such an extension to the profit-maximizing model has been used widely in the health economics literature (see e.g. Ellis and McGuire, 1986, Ma and McGuire, 1997, Chalkley and Malcolmson, 1998). The extension applies especially to physicians, from whom a certain degree of ethical behavior is often expected. We call such decision-maker an altruistic provider, as has become standard in the literature.

The question we are interested is whether an altruistic provider still has an incentive to dump high-cost patients. Eggleston (2000) shows that the providers' risk selection behavior depends on the degree of the provider altruism. She finds an inverse relationship between altruism and risk selection: the higher is the degree of the provider altruism, the lower is the effort the provider exerts to select good risks from the patient population.

In order to examine this question, we first rewrite the utility function of the provider to allow for altruistic preferences. The utility function of the altruistic provider is

$$V_1(t, a; h) \equiv \phi + \alpha u(h) - t \times f + (t \times a)[p - c(h) + \alpha\beta(h)], \qquad (10)$$

where the parameter $\alpha \geq 0$ measures the degree of the provider altruism. The case $\alpha = 0$ reduces to the selfish case that was analyzed above. In case of super agency α exceeds one (Ellis and McGuire, 1990), and the provider weights patient health benefit more than monetary variables like fee, fixed cost and profit margin.

We then show that when the degree of the provider altruism is sufficiently high, there is no prospective payment which would induce the provider to engage in dumping. To see why this holds true, suppose that there is a dumping equilibrium in which the g-type patient is treated and the b-type patient is not treated and the patient selects to accept the treatment and $\sigma = 1$. Then it must hold true that $\phi + \alpha u(g) < \phi - f + \alpha u(g) + p - c(g) + \alpha\beta(g)$ and $\phi + \alpha u(b) > \phi - f + \alpha u(b) + p - c(b) + \alpha\beta(b)$. These two conditions ensure that the altruistic provider chooses to treat the g-type patient and not to treat the b-type patient. These two equilibrium conditions simplify to

$$\gamma(g) - \alpha\beta(g) < p < \gamma(b) - \alpha\beta(b). \qquad (11)$$

If $\alpha \geq ICBR_{bg}$, then $\gamma(b) - \alpha\beta(b) \leq \gamma(g) - \alpha\beta(g)$ and there is no prospective payment, which would satisfy the condition (11). In words, if the degree of the physician altruism exceeds the incremental cost-benefit ratio $ICBR_{bg}$, there is no separating equilibrium in which the provider would engage in dumping. On the other hand, if $\alpha < ICBR_{bg}$, the prospective payment satisfying the condition (11) induces the provider to dump the high-cost patient and treat the low-cost patient.

The following proposition shows that when the provider is sufficiently altruistic, the provider treats the b-type patient and does not treat the g-type patient in the separating equilibrium of the model. This is the only separating equilibrium because dumping can not take place when $\alpha > ICBR_{bg}$.

Proposition 4 *The altruistic provider treats the b-type patient and does not treat the g-type and the patient accepts the treatment, if the prospective payment satisfies the conditions*

1. $\gamma(b) - \alpha\beta(b) < p < \gamma(g) - \alpha\beta(g)$ *and*
2. $p < \beta(b)/(1 + \lambda)$.

Equilibrium exists if $\alpha > \max\{ICBR_{bg}, \lambda/(1 + \lambda)\}$

6 Conclusion

In this article we have studied the relationship between prospective payment and patient selection. Our interest has focused on the conditions under which prospective payment induces health care providers to treat patients in different health states differently. We refer dumping as the situation, in which the low-cost patients are treated but the high-cost patients are left untreated.

We have used theoretical modeling techniques to explore the impact of exogenously determined prospective payment on treatment decisions. Our results show that if the provider maximizes profit, the provider engages in dumping if the prospective payment exceeds the cost of treating the g-type patient but is less than the cost of treating the b-type patient. Dumping is inefficient, if the patient in the bad health state obtains a higher net benefit from the treatment than the patient in the good health state. The extension of the model shows that if the provider is sufficiently altruistic, dumping does not take place in equilibrium.

A Appendix

Proof of Proposition 1 An equilibrium is a dumping equilibrium in pure strategies, if $\tau_1 = 1,\ \tau_2 = 0$ and $\sigma = 1$. Because $\sigma = 1$, the provider prefers (strictly) treat the g-type patient in the information set I_1^1, if

$$\sigma\,(\phi - f + p - c(g)) + (1-\sigma)\,(\phi - f) = \phi - f + p - c(g) > \phi. \tag{12}$$

From the condition (12) we obtain

$$p > c(g) + f. \tag{13}$$

Similarly, the provider declines the treatment of the b-type patient in the information set I_2^1, if

$$\phi > \phi - f + p - c(b). \tag{14}$$

It follows from the condition (14) that

$$p < c(b) + f \tag{15}$$

Putting together the conditions (13) and (15), we obtain $c(g)+f < p < c(b)+f$, which proves the first condition of the proposition.

In order to derive the second condition in the proposition, it suffices to observe that the patient's belief in the sequential equilibrium is $\mu = 1$. Therefore, $\sigma = 1$ if and only if

$$u(1) - (1+\lambda)(\phi + p) > u(g) - (1+\lambda) \tag{16}$$

or if $p < \beta(g)/(1+\lambda)$.

To derive the necessary condition for the existence of the equilibrium, contrary to the claim let us assume that $\beta(g)/(1+\lambda) \leq \gamma(g)$. Then there is no prospective payment p, which could satisfy the conditions

$$\gamma(g) < p < \min\{\frac{\beta(g)}{1+\lambda}, \gamma(b)\}.$$

||

Proof of Proposition 2 The provider treats g-type and b-type patients in the information sets I_1^1 and I_2^1, if

$$\phi < \phi - f + \sigma(p - c(g)) \tag{17}$$

and

$$\phi < \phi - f + \sigma(p - c(b)). \tag{18}$$

In equilibrium $p > c(b)$, because the condition (18) can not be satisfied if $p \leq c(b)$. The conditions (17) and (18) can then be rewritten as

$$\phi < \phi - f + \sigma(p - c(b)) < \phi - f + \sigma(p - c(g)) \tag{19}$$

In the pure-strategy equilibrium the patient accepts the treatment and $\sigma = 1$. Then the condition (19) simplifies to

$$0 < -f + p - c(b) < -f + p - c(g). \tag{20}$$

Therefore, it must hold true that $c(g) + f < c(b) + f < p$, which proves the first condition in the proposition.

Because $\tau_1 = \tau_2 = 1$ the patient holds beliefs $\mu = \pi$. Therefore, $\sigma = 1$ if and only if

$$\pi\beta(g) + (1 - \pi)\beta(b) > (1 + \lambda)p \tag{21}$$

which gives the condition 2. in the proposition. Existence follows from the comparison of $\gamma(b)$ and $[\pi\beta(g) + (1 - \pi)\beta(b)]/(1 + \lambda)$. ||

Proof of Proposition 3 Suppose that the patient uses the strategy $\sigma \in [0, 1]$. The provider does not offer treatment in the information sets I_1^1 and I_2^1, if

$$\phi > \phi - f + \sigma(p - c(g)) \tag{22}$$

and

$$\phi > \phi - f + \sigma(p - c(b)). \tag{23}$$

Let us first consider the case 1 in which the patient does not accept the treatment in equilibrium and $\sigma = 0$. Then the above two conditions (22) and (23) are satisfied because of the fixed cost. The patient does not accept the treatment in equilibrium, if

$$\begin{gathered} u(1) - (1 + \lambda)(\phi + p) < \\ \mu\left(u(g) - (1 + \lambda)\phi\right) + (1 - \mu)\left(u(b) - (1 + \lambda)\phi\right) \end{gathered} \tag{24}$$

or if

$$\mu < \frac{\beta(p) - (1+\lambda)p}{\beta(b) - \beta(g)}. \tag{25}$$

If $p \geq \beta(b)/(1+\lambda)$ then there is no $\mu \geq 0$ which would satisfy the condition (25). Therefore in addition for beliefs to satisfy (25) we must have the condition $p < \beta(b)/(1+\lambda)$ in a sequential equilibrium in which neither b-type nor g-type patient is treated and the patient does not accept the treatment.

Suppose next that the patient accepts the treatment in equilibrium and $\sigma = 1$. Then the conditions (22) and (23) imply

$$p < c(g) + f < c(b) + f, \tag{26}$$

which proves the two conditions present in the proposition. The patient chooses $\sigma = 1$ in equilibrium, if

$$\begin{gathered} u(1) - (1+\lambda)(\phi + p) > \\ \mu\left(u(g) - (1+\lambda)\phi\right) + (1-\mu)\left(u(b) - (1+\lambda)\phi\right) \end{gathered} \tag{27}$$

or if

$$\mu > \frac{\beta(b) - (1+\lambda)p}{\beta(b) - \beta(g)}. \tag{28}$$

If $p \leq \beta(g)/(1+\lambda)$, then there is no $\mu \leq 1$, which could satisfy the condition (28). Therefore, in addition for beliefs to satisfy the condition (28) the condition $p > \beta(g)/(1+\lambda)$ must hold true in a sequential equilibrium in which neither b-type nor g-type patients are treated and the patient accepts the treatment. In addition, for such equilibrium to exist we also need that $\beta(g) < (1+\lambda)\gamma(g)$. When $\lambda = 0$ such an equilibrium never exists under Assumption 1.

We still need to check the consistency of equilibrium beliefs. Let $\epsilon > 0$ and $0 < \mu < 1$, and consider two sequences of mixed strategies

$$\tau_1^n = \left(\frac{1}{\pi}\right)\left(\frac{\epsilon}{n}\right) \tag{29}$$

$$\tau_2^n = \left(\frac{1}{1-\pi}\right)\left(\frac{1-\mu}{\mu}\right)\left(\frac{\epsilon}{n}\right) \tag{30}$$

where $n = 1, 2, ...$ Now, clearly $\tau_i^n \to 0$ when $n \to \infty$. Then we obtain

$$\mu^n = \frac{\pi\tau_1^n}{\pi\tau_1^n + (1-\pi)\tau_2^n} = \mu \tag{31}$$

for all $n = 1, 2, ...$ Hence beliefs satisfying $0 < \mu < 1$ can be consistently derived from the strategies. ||

Proof of Proposition 4 The physician treats the b-type patient but does not treat the g-type patient, if

$$V_1(1, 1; b) > V_1(0, 1; b) \tag{32}$$

$$V_1(0, 1; g) > V_1(1, 1; g). \tag{33}$$

Then $\mu = 0$ and the patient accepts the treatment, if $U_2(1, 1; b) > U_2(0, 1; b)$. The conditions (32) and (33) can be simplified to

$$\gamma(b) - \alpha\beta(b) < p < \gamma(g) - \alpha\beta(g) \tag{34}$$

which proves the first condition of the proposition. The patient holds beliefs $\mu = 0$ and chooses $\sigma = 1$, if $\beta(b) > (1 + \lambda)p$. To show the existence, observe that $\gamma(g) - \alpha\beta(g) > \gamma(b) - \alpha\beta(b)$ if and only if $\alpha > ICBR_{bg}$. Secondly, for equilibrium to exist, we also need the condition $\beta(b) > \gamma(b)[(1+\lambda)/(1+(1+\lambda)\alpha)]$. But $[(1 + \lambda)/(1 + (1 + \lambda)\alpha)] < 1$ if and only if $\alpha > \lambda/(1 + \lambda)$. The condition for the existence of equilibrium combines these two conditions. ||

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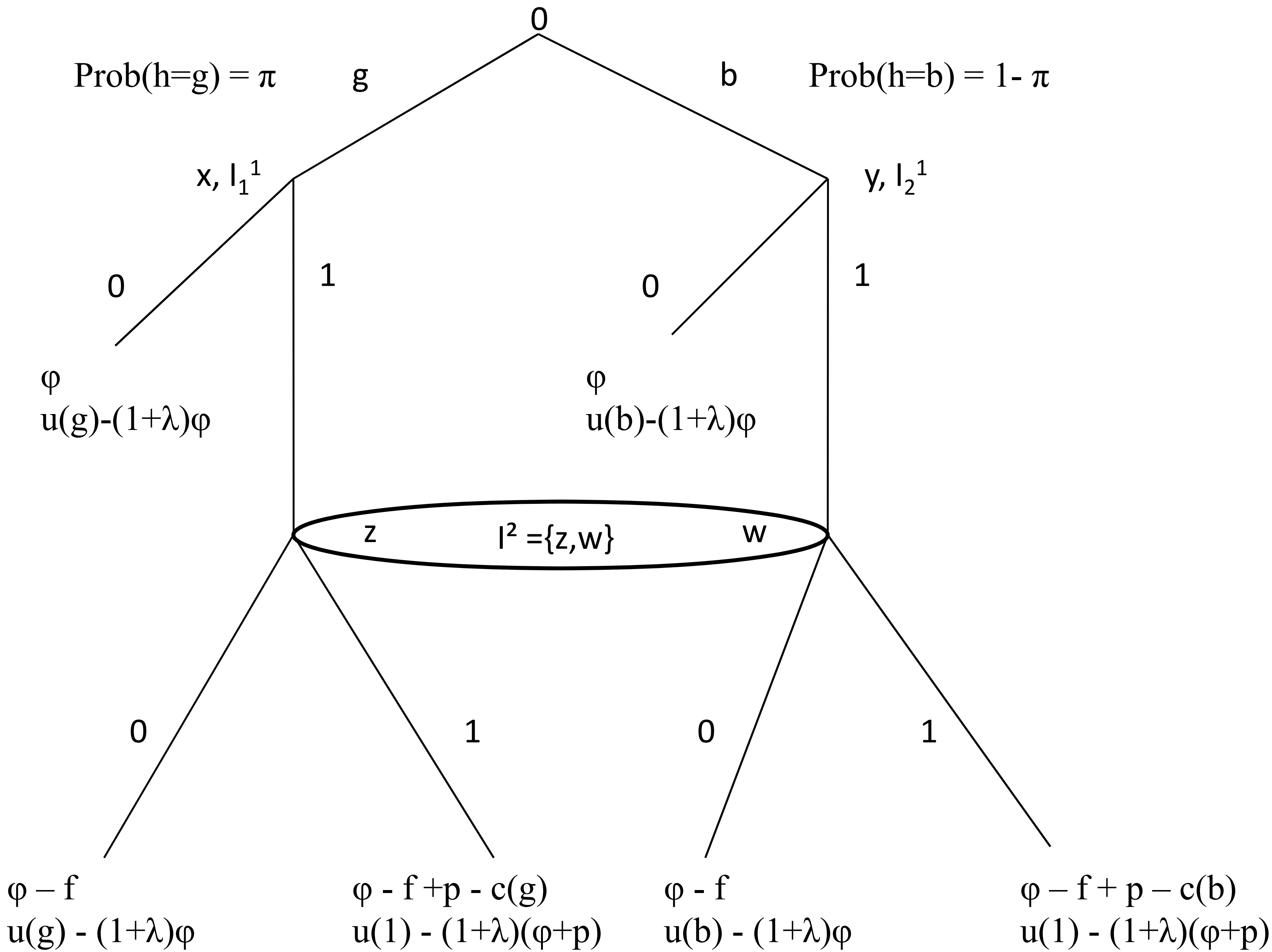
0
Prob(h=g) = π
g
b
Prob(h=b) = 1- π
x, I11
y, I21
0
1
0
1
φ
u(g)-(1+λ)φ
φ
u(b)-(1+λ)φ
z
I² ={z,w}
w
0
1
0
1
φ – f
u(g) - (1+λ)φ
φ - f +p - c(g)
u(1) - (1+λ)(φ+p)
φ - f
u(b) - (1+λ)φ
φ – f + p – c(b)
u(1) - (1+λ)(φ+p)