Competition between HMO and PPO: A Two-Sided Market Approach*

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Abstract

We set-up a two-sided market framework to model competition between a Prefered Provider Organization (PPO) and a Health Maintenance Organization (HMO). Both health plans compete to attract policyholders on one side and providers on the other side. The PPO, which is characterized by a higher diversity of providers, attracts riskier policyholders. Our two-sided framework allows to examine the consequences of this risk segmentation on the providers' side, especially in terms of remuneration. The outcome of competition mainly depends on two effects: a demand effect, influenced by the value put by policyholders on providers access and an adverse selection effect, captured by the characteristics of the health risk distribution. If the adverse selection effect is too strong, the HMO gets a higher profit in equilibrium. On the contrary, if the demand effect dominates, the PPO profit is higher in spite of the unfavorable risk segmentation. We believe that our model, by highlighting the two-sided market structure of the health plans' competition, provides new insights to understand the increase in the PPOs' market share observed during the last decade in the USA.

Keywords: Two-sided Markets, Managed Care Competition, Network Effects, Adverse Selection.

Jel Codes: I11, L11, L42.

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1 Introduction

Adverse selection is often presented as a major problem for competitive health insurance markets (Cutler and Zeckhauser, 1998). This phenomenon occurs when premiums set by health plans do not perfectly reflect the heterogeneity in policyholders' health risk. This imperfect risk adjustment can be caused by different reasons. For example, it may be impossible or too costly for insurers to set differentiated premiums taking into account the risk factors that would allow to reflect this heterogeneity. The regulation of health insurance contracts can also prevent health plans from setting premiums in an individual risk adjustment fashion. Moreover, when policyholders subscribe health insurance contracts linked to their jobs, employers often supply a menu of health insurance plans and also set employee premiums for each plan provided (Pauly *et al.*, 2004). In this case, health plans' premiums reflect differences in average total cost and not in individual expected health expenditure.

In this context, policyholders may be tempted, in an attempt to look for a health plan that supplies coverage against the lowest possible premium, to withdraw from plans that attract higher risks than himself. In a dynamical setting, this behavior can lead to a "death spiral" phenomenon (Buchmueller and Feldstein, 1997), whereby less restrictive plans attract high risks and therefore repel low and medium risks, with a cumulative effect. When an interior equilibrium occurs, high risks choose generous plans whereas low risks seek lower prices (Altman *et al.*, 1998). In equilibrium, since premiums reflect the average cost of a health plan's policyholders, the surplus of a policyholder depends on the characteristics of the other enrollees. This can be viewed as a negative network externality between policyholders.

As Chernew and Frick (1999) suggest, it is important to add a new variable (that they call "managedness") to the classical adverse selection models in order to capture fully the nature of managed care competition. For the health insurance sector, it seems that the diversity of physicians to whom policyholders have access is an instrument that strongly influences risk segmentation. Indeed, when MCOs adopt the Health Maintenance Organizations' form, policyholders cannot choose a physician outside the list of physicians affiliated to their HMOs. By contrast, in a Prefered Providers Organization policyholders can choose physicians who do not belong to the list of the network.[1] In contexts where health insurers are constrained from charging risk-rated premiums- such as in employer-sponsored multiple option benefits program or a regulated market - there is a tendency for higher risk consumers to select PPOs and lower risk policyholders to enroll in HMOs (Cutler and Reber [1998], Strombom *et al.* [2002], Buchmueller and DiNardo [2002], and Buchmueller and Liu [2006]).[2]

[1] However they may be charged for such a decision.

[2] We thank an anonymous co-editor for pointing out these references to us.

The present paper is among the first attempts[3] to model the two-sided nature of health plans' competition. By this we mean that health insurance markets are characterized by indirect network externalities between providers and policyholders' sides. Roughly speaking, a market structure is two-sided when "*an end-user does not internalize the full impact of his use of the platform on the welfare of another category of end-users.*" (Rochet and Tirole, 2005). In practice, health plans compete for policyholders on one side but also compete to attract physicians on the other side. The goal of our model is to shed some lights on indirect network externalities between these two sides of the health insurance market.

An asymmetric duopoly situation is considered in order to model competition between a PPO and a HMO, where the PPO is characterized by a larger network of providers. We use a vertical differentiation framework to capture the health risk heterogeneity between policyholders. The higher the risk of a policyholder, the more he values the diversity of providers, implying that the PPO attracts, on average, riskier policyholders.[4] In such framework, we compare the equilibrium profits of the HMO and the PPO. Which organization makes a higher profit depends mainly on two ingredients: the intensity of preference for diversity that characterizes policyholders and the health risk distribution's characteristics. First, on the policyholders' side, the PPO can charge a higher premium than the HMO thanks to the higher diversity supplied. Our results show that, all other things equal, a higher preference for diversity always plays in favor of the PPO. Second we show that the skewness of the risk distribution generates a complex interaction between the policyholders' and the providers' sides. When the upper tail of the risk distribution is thick enough, the PPO benefits from a higher demand but suffers from a strong adverse selection effect. If this adverse selection effect dominates, the HMO is able to make more profit by paying lower fee-for-service rates to its providers. By contrast, when this upper tail is not too thick the PPO makes higher profits in equilibrium. Our two-sided model provides new insights that might explain why, in spite of the unfavorable risk segmentation, PPOs have, in the USA, increased their market share at the expense of HMOs during the last decade.

Section 2 presents the model. Section 3 is devoted to the equilibrium analysis. Section 4 concludes, and discusses possible directions for extending our results.

[3] Two recent exceptions are Howell (2006) who provides a taxonomy for thinking about competition in health care markets and Pezzino and Pignatoro (2006) for a two-sided approach applied to hospitals that compete for doctors and patients. See also the last section in Demange and Geoffard (2007).

[4] This risk segmentation effect is already present in Baranes and Bardey (2008) in a context of competition between MCOs and conventional insurers. More precisely, their model follows the Salinger's framework in which vertical integrated insurers compete with conventional insurers (no integrated insurers). In such context, the remuneration of the providers who do not belong to a MCO is determined by a wholesale price which does not respond to a two-sided market mechanism. In other terms, they do not consider the impact of the network sizes on the physicians' remuneration.

2 The model

Three kinds of agents are considered:

- policyholders, who can become ill with an exogenous probability (no *ex ante* moral hazard is considered here). This probability θ is heterogenous across policyholders and is private information (we call it the "type" of the policyholder). It is distributed on $(0,1)$ according to a density f that is everywhere positive. The cumulative distribution function is denoted F.
- Physicians, who may decide to be affiliated with a health plan or not.
- Two competing health plans, indexed by i, with $i = \{PPO, HMO\}$. They provide health insurance contracts to policyholders and buy health care services from physicians.

When a policyholder (insured by i) becomes ill, he has the possibility to consult with any of the physicians who belong to i. The proportion of physicians (between 0 and 1) affiliated with network i is denoted J_i. Thus a higher J_i means more choice. The policyholder utility in case of illness u_I is thus an increasing function of J_i and of his net income c. For convenience, we adopt a separable specification[5]

$$u_I(c, J_i) = u(c) - \gamma + \lambda J_i, \tag{1}$$

where u is the utility in the absence of illness, γ is a nonpecuniary cost of being ill, and the parameter $\lambda > 0$ captures how patients value potential access to more physicians.[6] We assume that $\gamma \geq \lambda$. Note that there is an indirect externality, since the decisions of physicians to join one network have an impact on the utilities of policyholders. For simplicity, we assume that policyholders are fully insured: there is no copayment in case of illness.

The expected utility of a policyholder of type θ affiliated with insurer i is:

$$EU = u(w - P_i) + \theta[-\gamma + \lambda J_i], \tag{2}$$

where P_i is the premium paid by the policyholder to his insurer.

We assume that the premium is not too large (in comparison with the wealth of the policyholder) so that utility function u can be taken as linear (that is,

[5] Suppose for example that each illness can be cured by exactly one physician. The probability that this doctor is accessible to the patient is J_i. λ corresponds to the net utility of being cured. $(\gamma - \lambda)$ can be viewed as the utility loss caused by the treatment.

[6] This effect is very close to the Gal-Or's *ex post* differentiation effect (see Gal-Or [1997] and [1999]). This diversity valuation can also be viewed as a special case of Chernew and Frick's managedness variable.

wealth effects can be neglected).[7] Using this simplification, and normalizing $u'(w)$ to 1, we can approximate EU (up to a constant) by:

$$U_\theta(P_i, J_i) = \theta\lambda J_i - P_i. \tag{3}$$

The two health plans compete for policyholders on one side and physicians on the other side. The profit function of health plan i is:

$$\Pi_i = D_i P_i - T_i \tag{4}$$

where D_i is the number of policyholders affiliated with health plan i and T_i the total transfer paid to physicians. We assume that health plans are for-profit entities and have no other objective than maximizing their profits.

3 The outcome of competition between health plans

We first analyze the determination of market shares on policyholders' side. Next, we analyze physicians' side. Finally, we determine the global market equilibrium.

3.1 Risk segmentation among policyholders

On the policyholders' side, the market shares of the two insurers, namely D_{PPO} and D_{HMO}, determine the risk segmentation. More precisely, a policyholder characterized by a probability of illness θ chooses the PPO rather than the HMO if:

$$U_\theta(P_{PPO}, J_{PPO}) \geq U_\theta(P_{HMO}, J_{HMO})$$

To fix ideas, we assume that the PPO has more physicians affiliated than the HMO: $J_{PPO} > J_{HMO}$. We prove later that this property is satisfied in equilibrium.

In the case where the health insurance market is completely covered, the marginal policyholder's type $\tilde{\theta}$ is the one who is just indifferent between the PPO and the HMO:

$$\tilde{\theta} = \frac{P_{PPO} - P_{HMO}}{\lambda(J_{PPO} - J_{HMO})}. \tag{5}$$

Policyholders with a large probability of illness ($\theta \geq \tilde{\theta}$) choose the PPO, since it offers a larger diversity of physicians ($J_{PPO} \geq J_{HMO}$). Parameter λ captures the intensity of preferences for diversity. All other things equal, if λ increases, the price elasticity of policyholders' demand decreases.

[7] This assumption is not contradictory with a demand for insurance by policyholders (global risk aversion) if we consider illnesses with a very small probability of occurrence and a large cost of treatment. The premium will be small (so that wealth effects can be neglected) but uninsured people would face a large loss in case of illness and hence households prefer to buy insurance *ex ante*.

3.2 Physicians' diversity

For simplicity, we focus on the case where health plans do not compete for the same physicians. Thus, the two health plans have access to identical (but distinct) pools of physicians.[8] Think for example of a Hotelling type of model where a mass 1 of physicians are uniformly "located" on a $(0, 1)$ interval and incur a transportation cost proportional to their distance with the PPO (located at 0) or the HMO (located at 1). We consider the case where the physicians' market is not covered. This means that the numbers J_{PPO} and J_{HMO} of physicians affiliated respectively to PPO and HMO satisfy $J_{PPO} + J_{HMO} < 1$, and thus that the remaining $(1 - J_{PPO} - J_{HMO})$ physicians remain unaffiliated. In this case, the number J_i of physicians who affiliate with health plan i is only function of the net profit level[9] Φ_i offered by this health plan. Since we assume an uniform distribution of physicians, this function is linear: $J_i = \frac{\Phi_i}{\delta}$. δ represents the "transportation" cost of physicians and measures the sensitivity of physicians' supply to the net remuneration offered by health plans. To fix ideas we assume that doctors are remunerated by a fee-for-service rate R_i (if they affiliate with insurer i). Their profit level (including the cost of the time spent with the patient, which we call the "treatment cost") equals the product of the "profit margin" offered by the insurer (fee-for-service minus unit cost of treatment) by the level of activity that the physician expects to have if he joins the network. This expected activity level is equal to the expected number of consultations in the network, divided by the number of physicians affiliated.

Physicians' net profit levels, respectively when affiliated to PPO and HMO, are thus:

$$\Phi_{PPO} = \frac{(R_{PPO} - c)}{J_{PPO}} \int_{\tilde{\theta}}^{1} \theta dF(\theta),$$

and

$$\Phi_{HMO} = \frac{(R_{HMO} - c)}{J_{HMO}} \int_{0}^{\tilde{\theta}} \theta dF(\theta),$$

where c denotes the unit cost of treatment.[10] These formulas reveal the second indirect externality present in our model, this time from policyholders to physicians: the expected level of activity of physicians depends on the number and type of policyholders who join the insurer.

[8] We have checked that the case $J_{PPO} + J_{HMO} = 1$ leads to similar results but with computations much more complicated. Besides, the Hotelling's framework is well known to not suit well to pass from uncovered to covered markets. Moreover, it is worth noticing that in pratice we observe that some physicians remain unaffiliated.

[9] This profit is defined as the total remuneration of the physician, net of the cost (essentially the opportunity cost of time for the doctor) of examining and treating patients. It could be interesting to include non monetary aspects of a physician's utility, such as an altruistic component like in Jack (2005), Choné and Ma (2007) and Bardey and Lesur (2007).

[10] As pointed out by an anonymous referee, higher risk patients are likely to be more costly to treat on a per-visit basis. We have checked that introducing this additional feature would not alter significantly our results. A different version of the model that incorporates this feature is available upon request.

Thus health plans compete in two dimensions: the level P_i of insurance premiums and the number J_i of physicians they offer access to. In other words, we assume that they adjust the level of remuneration of their affiliated doctors (through R_i or Φ_i) in such a way that it allows to attract exactly the J_i doctors that decide to affiliate with insurer i. The assumption that health plans do not compete for the same doctors implies:[11]

$$\Phi_{PPO}J_{PPO} = \delta J_{PPO}^2 = (R_{PPO} - c)\int_{\tilde{\theta}}^{1} \theta dF(\theta) \tag{6}$$

and,

$$\Phi_{HMO}J_{HMO} = \delta J_{HMO}^2 = (R_{HMO} - c)\int_{0}^{\tilde{\theta}} \theta dF(\theta) \tag{7}$$

Note that the above formulas show the neutrality of our assumption that doctors are remunerated by fees-for-service. We could have assumed instead a capitation system. Since there is no uncertainty about the number and composition of the clientele of each physician (given the health plan they affiliate with), the strategic variable for each insurer is the net remuneration Φ_i they offer to physicians, independently of the way it is obtained.[12]

The structure of the two markets is represented in the figure below.

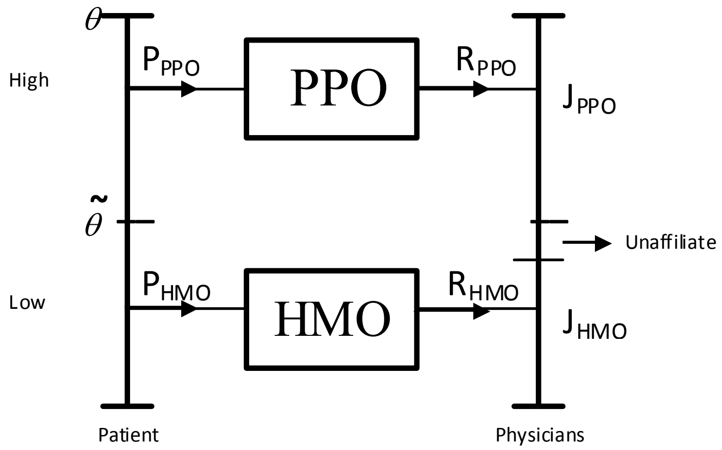

Figure 1: Market structure

[11] This assumption is satisfied as long as $J_{HMO} + J_{PPO} < 1$.

[12] We must recognize that the neutrality of the remuneration scheme is due to the providers' risk neutrality assumption. A possible extension of this model would be to consider risk averse providers. We guess that it would not change qualitatively the results. Indeed, as it is pointed out in Newhouse (1996), more prospective payment implies a risk transfer from insurers to providers. Therefore, in case of risk averse providers, the use of capitation payment would only imply to pay an additional risk premium to providers. However, a more complex challenge would be to consider both payment schemes *i.e.* capitation payments and fees-for-service, in the same framework. This case leads to the a multiplicity of equilibria as in Armstrong (2006).

3.3 Equilibrium

Given our assumptions, health plans' profits are:

$$\Pi_{PPO} = (1 - F(\tilde{\theta}))P_{PPO} - R_{PPO} \int_{\tilde{\theta}}^{1} \theta dF(\theta)$$

and,

$$\Pi_{HMO} = F(\tilde{\theta})P_{HMO} - R_{HMO} \int_{0}^{\tilde{\theta}} \theta dF(\theta)$$

It is convenient to express insurers' profits in terms of premiums P_{PPO} and P_{HMO} and physicians numbers J_{PPO} and J_{HMO}. Using (6) and (7), we obtain:

$$\Pi_{PPO} = (1 - F(\tilde{\theta}))P_{PPO} - \left(\delta J_{PPO}^2 + c \int_{\tilde{\theta}}^{1} \theta dF(\theta)\right),$$

and

$$\Pi_{HMO} = F(\tilde{\theta})P_{HMO} - \left(\delta J_{HMO}^2 + c \int_{0}^{\tilde{\theta}} \theta dF(\theta)\right),$$

where we recall that $\tilde{\theta} = \frac{P_{PPO} - P_{HMO}}{\lambda(J_{PPO} - J_{HMO})}$.

The PPO selects (P_{PPO}, J_{PPO}) to maximize its profit, taking (P_{HMO}, J_{HMO}) as given. The symmetric property holds for the HMO. The first-order conditions with respect to P_{PPO} and P_{HMO} give respectively

$$\frac{\partial \Pi_{PPO}}{\partial P_{PPO}} = 1 - F(\tilde{\theta}) + (P_{PPO} - c\tilde{\theta})f(\tilde{\theta})\frac{\partial \tilde{\theta}}{\partial P_{PPO}} = 0,$$

and

$$\frac{\partial \Pi_{HMO}}{\partial P_{HMO}} = F(\tilde{\theta}) + (P_{HMO} - c\tilde{\theta})f(\tilde{\theta})\frac{\partial \tilde{\theta}}{\partial P_{HMO}} = 0.$$

Since

$$\frac{\partial \tilde{\theta}}{\partial P_{PPO}} = -\frac{\partial \tilde{\theta}}{\partial P_{HMO}} = \frac{1}{\lambda(J_{PPO} - J_{HMO})},$$

we obtain:

$$P_{PPO} = \tilde{\theta}c + \lambda(J_{PPO} - J_{HMO})\frac{1 - F(\tilde{\theta})}{f(\tilde{\theta})}, \tag{8}$$

and

$$P_{HMO} = \tilde{\theta}c + \lambda(J_{PPO} - J_{HMO})\frac{F(\tilde{\theta})}{f(\tilde{\theta})}. \tag{9}$$

Using equation (5), that defines $\tilde{\theta}$, we obtain:

$$\tilde{\theta} = \frac{P_{PPO} - P_{HMO}}{\lambda(J_{PPO} - J_{HMO})} = \frac{(1 - 2F(\tilde{\theta}))}{f(\tilde{\theta})}, \tag{10}$$

and finally the two market shares are given by:

$$\begin{aligned} D_{PPO} &= 1 - F(\tilde{\theta}), \\ D_{HMO} &= F(\tilde{\theta}). \end{aligned}$$

Thus we see that the market shares on the policyholders' side only depend on the properties of F, the distribution of risks. If F satisfies the monotone hazard rate property, there is an unique $\tilde{\theta}$ that satisfies equation (10). In the case of an iso-elastic distribution $F(\tilde{\theta}) = \tilde{\theta}^{\epsilon}$ we obtain:

$$\tilde{\theta} = (\frac{1}{2+\epsilon})^{\frac{1}{\epsilon}},$$

which implies

$$D_{PPO} = 1 - \tilde{\theta}^{\epsilon} = \frac{1+\epsilon}{2+\epsilon},$$

and

$$D_{HMO} = \tilde{\theta}^{\epsilon} = \frac{1}{1+\epsilon}.$$

This shows that the market share of the PPO (the one with the larger variety of physicians) is always larger than 1/2, and increases with parameter ϵ, which captures the concentration of high risks.

The first-order conditions with respect to J_{PPO} and J_{HMO} give respectively

$$-\left[P_{PPO} - \tilde{\theta}c\right]\frac{\partial\tilde{\theta}}{\partial J_{PPO}}f(\tilde{\theta}) - 2\delta J_{PPO} = 0,$$

and

$$\left[P_{HMO} - \tilde{\theta}c\right]f(\tilde{\theta})\frac{\partial\tilde{\theta}}{\partial J_{HMO}} - 2\delta J_{HMO} = 0.$$

Replacing P_{PPO} and P_{HMO} by their values given by (8) and (9), and using again the fact that $\frac{\partial\tilde{\theta}}{\partial J_{PPO}} = -\frac{\partial\tilde{\theta}}{\partial J_{HMO}} = -\frac{\tilde{\theta}}{J_{PPO}-J_{HMO}}$, we obtain:

$$J_{PPO} = \frac{\lambda}{2\delta}\tilde{\theta}\left[1 - F(\tilde{\theta})\right],$$

and

$$J_{HMO} = \frac{\lambda}{2\delta}\tilde{\theta}F(\tilde{\theta}).$$

Note that the PPO has always more than half of the market: $F(\tilde{\theta}) < 1/2$. This implies that the PPO has also more physicians ($J_{PPO} > J_{HMO}$) than the HMO. This property was assumed from the start and needed to be checked in equilibrium.

The equilibrium fee-for-service rates are respectively:

$$R_{PPO} = c + \frac{\delta J_{PPO}^2}{\int_{\tilde{\theta}}^1 \theta dF(\theta)} = c + \frac{\lambda^2}{4\delta}\frac{\tilde{\theta}^2\left[1 - F(\tilde{\theta})\right]^2}{\int_{\tilde{\theta}}^1 \theta dF(\theta)}, \tag{11}$$

and

$$R_{HMO} = c + \frac{\delta J_{HMO}^2}{\int_0^{\tilde{\theta}} \theta dF(\theta)} = c + \frac{\lambda^2}{4\delta}\frac{\tilde{\theta}^2 F(\tilde{\theta})^2}{\int_0^{\tilde{\theta}} \theta dF(\theta)}. \tag{12}$$

Finally, premiums are given by:

$$P_{PPO} = \tilde{\theta}c + \frac{\lambda^2}{2\delta}\tilde{\theta}^2[1 - F(\tilde{\theta})],$$

and

$$P_{HMO} = \tilde{\theta}c + \frac{\lambda^2}{2\delta}\tilde{\theta}^2 F(\tilde{\theta}).$$

Note that the PPO charges a higher premium than the HMO ($P_{PPO} > P_{HMO}$). As for the ratio of (net) fee-for-service rates:

$$\frac{R_{PPO} - c}{R_{HMO} - c} = \left[\frac{1 - F(\tilde{\theta})}{F(\tilde{\theta})}\right]^2 \times \frac{\int_0^{\tilde{\theta}} \theta dF(\theta)}{\int_{\tilde{\theta}}^1 \theta dF(\theta)},$$

it is also equal to

$$\frac{R_{PPO} - c}{R_{HMO} - c} = \frac{1 - F(\tilde{\theta})}{F(\tilde{\theta})} \times \frac{E[\theta|\theta < \tilde{\theta}]}{E[\theta|\theta > \tilde{\theta}]}. \tag{13}$$

This formula illustrates how the PPO can, in somes cases, paradoxically benefit from attracting riskier policyholders. Indeed, the higher volume of activity (per patient) that it can offer to its affiliated physicians (since $E[\theta|\theta > \tilde{\theta}] > E[\theta|\theta < \tilde{\theta}]$) reduces the equilibrium level of fee-for-services rates (second ratio in the formula above). However to obtain higher market share on the policyholders' side implies attracting more physicians and thus offering more remuneration to them (first ratio). Which effect dominates depend on the characteristics of the distribution F. Thus the PPO can, in some cases, pay lower fees than the HMO. This case occurs only when the market share effect dominates the adverse selection effect. Dor *et al.* (2004) observe that, on average, PPOs' price are 8% lower than conventional insurers' ones, while HMOs obtain a discount of 24%. In our two-sided context, it means that the adverse selection effect dominates the demand's one.

If we summarize our results in the case of an iso-elastic distribution, we have:

$$\frac{D_{PPO}}{D_{HMO}} = \frac{J_{PPO}}{J_{HMO}} = 1 + \epsilon,$$

and the ratio of fee-for-service rates is given by:

$$\frac{R_{PPO} - c}{R_{HMO} - c} = \frac{(1+\epsilon)^2}{(2+\epsilon)^{\frac{1+\epsilon}{\epsilon}} - 1}.$$

This ratio may be greater or smaller than 1, depending on the value of ϵ, as it can be observed easily in the following graph.

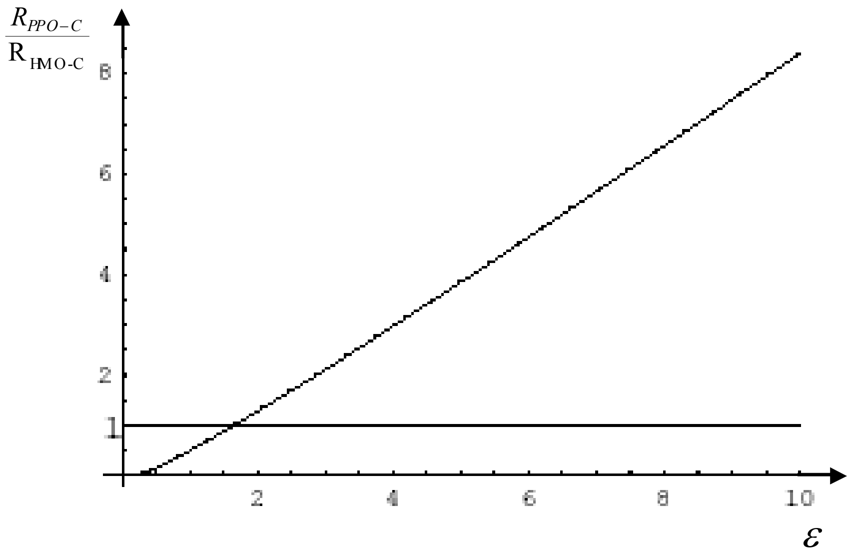

Figure 2: Fee-for service rates ratio

For purpose of illustration, in the case of an uniform distribution ($\epsilon = 1$), we have

$$\begin{aligned} D_{PPO} &= 2D_{HMO} \\ J_{PPO} &= 2J_{HMO} \\ R_{PPO} - c &= \frac{1}{2}(R_{HMO} - c). \end{aligned}$$

The uniform distribution case allows to illustrate that when ϵ is low enough, the demand effect dominates, and the PPO is able to pay a lower fees-for-service to its physicians. For higher values of ϵ, the adverse selection effect dominates and the opposite result occurs: the HMO pays lower fee-for-service rates.

Proposition 1 *When $\frac{\lambda}{\delta}$ is small enough,*[13] *the market equilibrium is characterized by the following properties:*

- *The market shares on the policyholders' side only depends on the distribution of risks:*
$$\tilde{\theta} = \frac{(1 - 2F(\tilde{\theta}))}{f(\tilde{\theta})}. \tag{14}$$
- *The numbers of physicians affiliated with each insurer are proportional to the ratio $\frac{\lambda}{\delta}$:*
$$\begin{aligned} J_{PPO} &= \frac{\lambda}{2\delta}\tilde{\theta}\left[1 - F(\tilde{\theta})\right], \\ J_{HMO} &= \frac{\lambda}{2\delta}\tilde{\theta}F(\tilde{\theta}). \end{aligned}$$
- *The mark-ups on insurance premiums increase with λ and decrease with δ:*
$$\begin{aligned} P_{PPO} - \tilde{\theta}c &= \frac{\lambda^2}{2\delta}\tilde{\theta}^2[1 - F(\tilde{\theta})], \\ P_{HMO} - \tilde{\theta}c &= \frac{\lambda^2}{2\delta}\tilde{\theta}^2 F(\tilde{\theta}). \end{aligned}$$

By replacing premiums and physicians' numbers by their equilibrium values in the formulas giving insurers' profits, we obtain the equilibrium values of these insurers' profits:

$$\begin{aligned} \Pi_{PPO} &= \frac{\lambda^2}{4\delta}\tilde{\theta}^2[1 - F(\tilde{\theta})]^2 - c\left[\int_{\tilde{\theta}}^{1}(\theta - \tilde{\theta})dF(\theta)\right], \\ \Pi_{HMO} &= \frac{\lambda^2}{4\delta}\tilde{\theta}^2 F(\tilde{\theta})^2 - c\left[\int_{0}^{\tilde{\theta}}(\theta - \tilde{\theta})dF(\theta)\right]. \end{aligned}$$

The first terms in these formulas capture the impact of the market share effect on the networks' profit. By offering more choice, the PPO secures a higher market share $(1 - F(\tilde{\theta}) > F(\tilde{\theta}))$ which combines with a higher mark-up $\left(\frac{\lambda^2}{2\delta}\tilde{\theta}^2[1 - F(\tilde{\theta})] > \frac{\lambda^2}{2\delta}\tilde{\theta}F(\tilde{\theta})\right)$.

The second terms in the above formulas represent the impact of the adverse selection effect: the incremental cost of inframarginal patients is positive for the PPO (since $\theta > \tilde{\theta}$ on $(\tilde{\theta}, 1)$), while it is negative for the HMO (since $\theta < \tilde{\theta}$ on $(0, \tilde{\theta})$). Which effect dominates depends on the parameters, as shows in Proposition 2.

[13] The precise condition is $\frac{\lambda}{\delta} < \frac{2}{\tilde{\theta}}$, where $\tilde{\theta}$ is the unique solution of (14). This condition ensures that $J_{HMO} + J_{PPO} < 1$, which was assumed initially.

Proposition 2 *The equilibrium profit of the PPO is higher than that of the HMO if* $\frac{\lambda^2}{4\delta c} > K(\tilde{\theta})$, *with* $K(\tilde{\theta}) = \frac{\int_0^1 |\tilde{\theta}-\theta| dF(\tilde{\theta})}{(1-2F(\tilde{\theta}))\tilde{\theta}^2}$

Proof. By the above formulas we have:

$$\Pi_{PPO} - \Pi_{HMO} = \frac{\lambda^2}{4\delta}\tilde{\theta}^2[1 - 2F(\tilde{\theta})] - c\int_0^1 |\theta - \tilde{\theta}| dF(\theta),$$

hence the desired result. ■

The contribution of Proposition 2 is to identify the main parameters that influence the market outcome. More precisely, in equilibrium, the PPO makes a lower profit than the HMO if policyholders' preference for diversity (captured by λ) is low enough. The parameters δ and c work in the opposite direction. The profits' comparison also depends on the characteristics of the health risk distribution. The HMO has a higher profit as long as the adverse selection effect is stronger than the demand effect. In this case, the providers' side component of the health plans' profit function is in favor of the HMO and can more than offset the higher premium set by the PPO on the policyholders' side. This situation is in line with some studies that have revealed that PPOs can suffer from death spirals too (Yegian *et al.*, 2000). On the contrary, if the demand effect is stronger than the adverse selection effect, then the PPO "wins" on both sides.[14] Another situation in which the PPO can get higher profit occurs when the higher premium obtained on policyholders' side can more than offset the higher fee-for-service rate paid on providers' side. This result might explain why PPOs have increased their market share during the last decade at expense of HMOs.

4 Conclusion

In this paper, we analyze the outcome of competition between a PPO and a HMO. Our two-sided framework helps identifying conditions under which a PPO can get a higher profit than a HMO in line with the rise in "intermediate managed care plans" such as PPOs (Morrisey and Jensen, 1997). Indeed, the growth of PPOs not only coincided with general growth of managed care, but during the last decade, has come also at the expense of other managed care forms as HMOs (Hirth *et al.*, 2007).[15]

As mentioned in Howell (2006), the two-sided nature of the health care industry may have some important implications for competition policy issues.

[14] It is worth noticing that the indirect externality effect revealed by our two-sided structure is consistent with Sorensen (2003)'s empirical results who shows that the market share of Health Plans has a positive impact on their bargaining power *vis-à-vis* providers.

[15] The PPOs' market share in the employer-sponsored market grew from 11% to 55% between 1988 and 2004. Moreover, between 1999 and 2004, it is worth mentioning that PPOs' market share rose by 16% while conventional insurers' enrollment decreased by only 5% (Kaiser, 2004). Hirth et al (2006) interprets this as a growth of PPOs' market share at the expense of HMOs'.

Even if our paper only provides a first analysis, our model allows to highlight the role of indirect externalities between the two sides of the market. More precisely, using a one-sided logic, one could have thought that the unfavorable risk segmentation faced by the more flexible health plans would systematically encourage MCOs to restrict the choice of physicians. In such a context, vertical agreements could have been perceived as anticompetitive: the more restrictive is the health plan, the lower is the risk of his policyholders and the higher its profit. On the contrary, our two-sided framework allows to explain the phenomenon of higher flexibility that has been observed during the last decade in the United States. In terms of competition policy, this suggests that the degree of vertical integration in the health insurance sector does not systematically introduce competitive distortions.

Our analysis could be extended in several directions:

- Introducing a copayment whenever a patient visits a physician outside his healthcare network can be a useful policy instrument for health plans. MCOs usually use copayments as an incentive to limit expenses. Analyzing such copayments would require to model the patients' *ex post* choices between physicians belonging to their network and the others.

- It might be relevant to introduce other types of heterogeneity among physicians such as their degree of altruism (see Jack [2005] and Choné and Ma [2007]) or outside options (or opportunity cost of their time). In this case, the features of our equilibrium could be changed. Physicians with a high opportunity cost of time would probably prefer to choose the health plan with the lowest demand for health care.

- It could be interesting to add an *ex post* moral hazard component to the model. Controls on utilization are stronger in HMOs structures and may lead to a lower level of health care consumption. This could reduce the possibilities of PPOs to compete successfully with HMOs.[16]

- We have used a duopoly model. It would also be interesting to extend it to an oligopoly framework in order to analyze concentrations and mergers aspects.[17] An oligopoly framework would also allow to analyze the relative bargaining powers of health plans and physicians groups according to the relative concentration of their markets.[18]

- We have assumed exclusivity: physicians can only be affiliated with an unique MCO. In practice, some physicians work for several networks and are not constrained by exclusivity contracts. Since health plans are exclusive on the policyholders' side, this may lead to a "competitive bottleneck" situation as described in Armstrong (2006).

[16] We are grateful to two anonymous referees for pointing out this effect.

[17] This is done in Gal-Or (1999).

[18] One could extend the analysis of Brooks *et al.* (1997) to a two-sided framework.

In conclusion, let us repeat that although this paper focuses on some specific dimensions, the analysis provided here already suggests some interesting consequences of the two-sided nature of the health insurance market. As advocated eloquently by Wright (2004), policy makers have to be careful in order to avoid the fallacies of one-sided logic applied to a two-sided context.

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