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Competition between Managed Care Organizations and Indemnity Plans in Health Insurance Markets

Edmond Baranes* David Bardey‡

Abstract

This paper examines a model of competition between two types of health insurers: Managed Care Organizations (MCOs) and "Conventional Insurers". MCOs vertically integrate health care providers and pay them at a competitive price, while conventional insurers work as indemnity plans and pay the health care providers that are freely chosen by their policyholders at a wholesale price. This first difference is called input price effect. Moreover, we assume that policyholders put a positive value on providers' diversity supplied by their health insurance plan and that this value increases with their probability of disease. Due to the restricted choice of health care providers in MCOs, a risk segmentation occurs: policyholders who choose conventional insurers are characterized by a higher risk. Surprisingly, our results point out that the effects of this input price and risk segmentation can be countervailing and do not necessarily work in the same direction. More precisely, we show that vertical integration in health insurance markets can create an anti-raise rivals' cost effect. Consequently, our results reveal that the penetration of vertical integration may decrease conventional insurers' premiums, which is a sufficient condition to be Pareto-improving. After more than three decades of vertical integration waves, our model may also explain why we observe an interior equilibrium in which conventional insurers have survived.

Keywords: Vertical Integration, Managed Care Organization, Competition Policy.
Jel Classification: L42, I11 and G22.

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Competencia entre aseguradores integrados y tradicionales en los mercados de seguros de salud[1]

Edmond Baranes[2] y David Bardey[3]

Resumen

Este artículo propone un análisis en el cual se modela la competencia entre dos tipos de aseguradores: integrados (MCOs) y tradicionales. Los MCOs integran verticalmente a los proveedores de salud y les pagan sus servicios a un precio competitivo (costo marginal), mientras que, los aseguradores tradicionales simplemente reembolsan a los proveedores de salud, libremente escogidos por sus afiliados, a un precio de mercado. Esta primera diferencia es llamada efecto precio. Además, se asume que los asegurados valoran positivamente la diversidad de proveedores a los cuales tienen acceso gracias a su plan de salud y que esta valoración aumenta con su probabilidad de estar enfermo. Debido a las elecciones restringidas de los proveedores de salud con los MCOs, una segmentación de los riesgos ocurre: los asegurados que escogen aseguradores tradicionales se caracterizan por un riesgo mayor. De manera sorprendente, nuestros resultados revelan que estos efectos precios y de segmentación de los riesgos pueden actuar en direcciones opuestas. Más precisamente, se muestra que la integración vertical en los mercados de seguros de salud puede generar un efecto opuesto al efecto tradicional de incrementar el costo de los competidores. En consecuencia, nuestros resultados revelan que la penetración de la integración vertical disminuye las primas de los aseguradores tradicionales, lo cual constituye una condición suficiente para ser Pareto-improving. Después de tres décadas de ola de integración vertical, nuestro modelo permite explicar porque todavía existe un equilibrio interior en el cual los aseguradores tradicionales han sobrevivido.

Palabras claves: Integración vertical, Asegurador integrado, Política de la competencia.

Códigos JEL: L42 and I11.

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1 Queremos agradecer a Jean-Charles Rochet, Helmuth Cremer, Philippe Choné, Claude Montmarquette, Laurent Linnemer, Laurent Flochel, Romain Lesur, Jorge Ferrando, Dan Kovenock, Anna Toldra, Elena Argentesi y Dario Maldonado. Cualquier error u omisión es responsabilidad exclusiva de los autores.

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1 Introduction

Even though few articles theoretically analyze the consequences of vertical integration in the health insurance sector,[1] it is often presented as an efficient remedy for reducing or containing increasing health care expenditures. Several reasons are given to explain this point of view. First, vertical integration allows insurers to reduce providers' moral hazard (Ma and Riordan, 2002) and transaction costs. Second, MCOs negotiate lower prices with health care providers that allow them, at quantity given, to reduce health expenditures.[2] Third, in the USA context, MCOs' penetration has been associated with increased of the competition in the health insurance sector (Baker and Corts, 1996). However, in spite of these optimistic views, it is known that vertical restraints can lead to anti-competitive situations.[3] More precisely, vertical integration may create incentives for foreclusion and then increase the upstream market concentration and consequently the input prices for (non integrated) downstream firms: the so-called "*raise rival cost*" effect. In the health insurance sector, vertical restrictions may also generate a risk segmentation among policyholders. Indeed, policyholders value the diversity their health insurance plan provides and this value increases with the probability of disease. Roughly speaking, policyholders characterized by high probabilities of disease tend to prefer to be affiliated to conventional insurers which do not restrict their choice of health care providers. It is difficult to disentangle these effects and, in particular to understand if the MCOs' lower costs are due to this risk segmentation, a raise rival cost effect or to the previous positive arguments mentioned. At this stage of the analysis, it is worth noting that taken separately, the raise rival cost and the risk segmentation effects work in the same direction and should yield to an increase in the conventional insurers' premium.

In this paper, we provide a simple theoretical model allowing us to analyze the relationship between the MCOs' market share and the variation in the conventional insurance premiums. We use Salinger's traditional framework of vertical integration to model competition between MCOs and conventional insurers. Conventional insurers and MCOs compete each other but we assume that, within each sub-market, the conventional insurers and MCOs sub-markets are each characterized by perfect competition. In other words, at equilibrium, both types of health insurance plan are charged at respective marginal costs. Nevertheless, the marginal costs of conventional insurers and MCOs differ in two aspects: the price paid to health care providers, which may involve a raise rival cost effect, and the average health risk of

[1] See for instance the recent review of literature provided by Gaynor and Town (2011).
[2] See Cutler, McClellan and Newhouse (2000) and Melnick *et al* (1992) for empirical evidences.
[3] See Rey and Tirole (2005) for a literature review.

their respective policyholders, *i.e.* the risk segmentation effect. Concerning the first aspect, following Salinger (1988), we suppose that the vertical integration allows MCOs to pay the health care delivered by affiliated providers at their marginal cost, whereas conventional insurers have to pay a wholesale price to health care providers. To capture the second aspect, we add an endogenous risk segmentation to Salinger's framework between conventional insurers and MCOs. *Ceteris paribus*, policyholders with a higher risk of disease prefer to be insured with conventional insurers that do not restrict the access to health care providers. Following Salinger (1988), we consider a given market structure and provide some comparative static analysis to focus on the effects of the market share of MCOs on health insurance premiums (conventional insurers and MCOs premiums).[4] Our model attempts to understand the interplay between the risk segmentation and the health care price effects. Without assuming that presence of MCOs increases the competitive pressure arguments, our results show that the penetration of MCOs can, in some cases, reduce conventional insurers' premiums which, in such a context, constitute a sufficient condition to guarantee that MCOs penetration is Pareto-improving. The model allows us to determine that the level of health care marginal cost constitutes a key factor in the vertical integration welfare consequences in health insurance markets.

The rest of the paper is organized as follows. Section 2 presents the set up. Section 3 gives the outcome of the equilibrium and its properties are discussed. We conclude in Section 4.

2 The model

We introduce a model in which health insurance companies compete with each other for policyholders, while providers offer health care to patients affiliated with insurance companies. This section presents the key assumptions of the model.

2.1 The health insurance companies

We assume that there exist two types of health insurance plans, conventional insurers and MCOs, NI and I respectively, and we note n the number of MCOs among insurance companies.[5] The difference between both insurance plans is that MCOs offer a restricted list of providers to policyholders, while conventional insurers allow policyholders to freely choose among the providers available in the health care market. For

[4] Bardey and Bourgeon (2011) consider an endogenous market structure but they do not tackle the risk segmentation issue.

[5] As we shall observe later on, the number of conventional insurers does not matter.

the purpose of simplicity, we assume that policyholders who choose MCOs can get care only from one provider. Moreover, we assume that insurance companies bear no cost other than the price of the health care they pay to providers for conventional insurers and MCOs, R and r respectively. Conventional insurers charge a premium P_{NI} to the policyholders, and the MCOs a premium P_I. Assuming that insurance companies are identical,[6] in each sub-market yields a perfect competition within each sub-market and both types of insurance plans are charged to a price equal to their respective marginal costs. Both marginal costs depend on the average risk of the policyholders who choose the insurance plans on the one hand, and on the price paid to providers on the other hand.

2.2 The providers

We assume J providers offer health care to insurance companies. We suppose that each provider bears a constant marginal cost, noted as c. We assume that MCOs sign exclusive contracts with providers. That is, a provider who works for an MCO cannot supply health care to patients who are not affiliated to that MCO. Consequently, for a given number of providers, the prevalence of such contracts reduces the diversity of providers available to policyholders who choose a conventional insurers. Hence, as we have n MCOs and each MCO offers access to one provider, it implies that policyholders who choose conventional insurer have access to $J - n$ providers when they fall ill.[7]

Following Salinger (1988), the exclusive contracts between MCOs and affiliated providers lead to a crucial difference between both types of insurance plans. Conventional insurers pay providers for health care at a wholesale price R that includes a mark-up based on c whereas MCOs, thanks to their vertical structure, get health care at the marginal cost c, that is $r = c$.[8] Finally, we consider a competition between the independent providers using a circular location model. We normalize the length of the circle to 1 and we note provider i's location by $x_i \in \{1, ..., J - n\}$, where the $J - n$ providers are located at equal distance from each other.

[6] At least from an ex ante perspective, we shall see later that ex post MCOs are differentiated due to the providers' differentiation.

[7] For simplicity, we consider a situation of single-homing, in which providers affiliated to an MCO cannot offer health care to patients insured through another insurance company.

[8] Although this assumption does not explain the providers' incentives of belonging to MCOs, it remains the easiest way for modeling the difference between integrated and non-integrated health insurers. For instance, providers can prefer to work in a MCO for several reasons: salary stability (in a staff model HMO), reputation, etc...

2.3 The policyholders

We assume that policyholders can obtain health care when they become ill only by purchasing a health insurance contract.[9] We assume that policyholders benefit from a full insurance coverage and do not pay any out-of pocket expenses. Following Gal-Or (1997, 1999), we assume that policyholders are differentiated according to two dimensions.[10] The first one is an *ex ante* distribution of their probability of disease, noted by θ, which is uniformly distributed over $[0, 1]$ and corresponds to the probability of health care consumption. The second dimension is an *ex post* uniform distribution over a circle of length one that reflects the type of disease affecting policyholders when they become ill. The *ex post* address of policyholders is noted by x, and we assume a linear transportation cost, noted t. This *ex post* differentiation captures the following idea: when policyholders choose their health insurer (conventional insurer or MCO), they do not know *ex ante* from which kind of disease they will suffer if they become ill, and consequently, do not know which is the best provider to treat their disease. This *ex post* differentiation can be interpreted as preferences for diversity under the veil of ignorance and yields to a vertical differentiation according to the type of health insurers chosen. Roughly speaking, policyholders characterized by a high probability of being sick, *ceteris paribus*, prefer conventional insurers rather than MCOs due to the diversity of providers to which they have access with the former. Patients may bear a higher expected transportation cost being insured with a MCO because the provider to which they have access is not necessarily the most suitable according to the disease captured by their address x.

Let us now give the policyholders' expected utility function:

$$U = u + 2\theta y \int_0^{1/2y} (v - tx)dx - P. \tag{1}$$

The first term of the utility function represents the gross utility that the individual can get without an insurance plan. It can be viewed as the expected utility that the individual get in the absence of insurance. The second term measures the benefit that a policyholder characterized by a probability θ derives from the insurance plan. Thanks to their plan, when they become ill, they benefit from health care that gives a utility v, minus the expected transportation cost according to the provider they are allowed to choose. This expected transportation cost mainly depends on the number y of providers accessible and the probability of disease θ. Finally, policyholders have to pay a premium P to be insured.

[9] See Gal-Or (1999) for a similar assumption.

[10] For the slake of simplicity, we assume that *ex ante* and *ex post* distributions are independent.

Remember that policyholders have access to only one provider if they choose a MCO and to $K = J - n$ when they are insured by a conventional insurer. Consequently, expected utilities for policyholders affiliated to a conventional insurer and a MCO are respectively:

$$U_{NI}(\theta) = u + 2\theta K \int_0^{1/2(J-n)} (v - tx)dx - P_{NI} \tag{2}$$

and,

$$U_I(\theta) = u + 2\theta \int_0^{1/2} (v - tx)dx - P_I, \tag{3}$$

where P_{NI} and P_I denote the premium charged by conventional insurers and MCOs, respectively.

From (2) and (3), we can deduce the marginal policyholder between the two insurance plans. Hence, a policyholder, given a probability of disease θ, prefers to buy a health insurance contract from a conventional insurer rather than from an MCO if

$$U_{NI}(\theta) \geq U_I(\theta). \tag{4}$$

We note $\tilde{\theta}$ the marginal policyholder, indifferent between the two types of health insurance plans. So, the last inequality applies if and only if

$$\theta \geq \tilde{\theta}(K) = \frac{(P_{NI} - P_I)\,4\,(J-n)}{t\,(J-n-1)}. \tag{5}$$

A policyholder with a higher probability of disease than $\tilde{\theta}(K)$ prefers to choose a conventional insurer to enable choice of provider if they become ill even if they have to pay a higher premium. We can observe that $\tilde{\theta}(K)$ decreases with K and consequently increases in n. That is, *ceteris paribus*, conventional insurers obtain a higher market share when they provide a greater diversity of providers. Note that their market share also increases with t, which is an inverse measure of the substitutability between the two types of insurance plans.

3 Equilibrium Analysis

We apply the standard sequential game that is used in the vertical integration literature to characterize the equilibrium. In the first stage, we determine the wholesale price at the upstream level (the providers' market). In the second stage, we derive the equilibrium prices at the downstream level (*i.e.* the insurance sector). The game is solved backwards.

3.1 Downstream Competition

At the downstream level, we assume that insurers compete *à la Bertrand* in each sub-market of the insurance market (MCOs and conventional insurers' sub-markets). In other words, we assume perfect competition and that no-loading factors matter in both health insurance markets. Therefore, in the conventional insurance market, premiums P_{NI} are equal to their marginal cost.[11]

$$P_{NI} = \left(\frac{1+\tilde{\theta}}{2}\right) R \tag{6}$$

where $(1+\tilde{\theta})/2$ represents the average probability of disease of policyholders who choose conventional insurers while R is the price of the health care paid by insurers to providers.

Ex ante, policyholders do not know their *ex post* address (the type of disease they will suffer if they become ill), hence when they choose their health insurance contract, they have no particular preferences for a specific provider. Behind this veil of ignorance, there is no differentiation in the MCO submarket even though the "good" sold is different from an *ex post* perspective. Indeed, differentiation is *ex post* but competition between MCOs is *ex ante*. Consequently, MCOs cannot fix a positive mark-up without losing all their market share and their premiums are equal to their marginal costs: the health care marginal cost c, weighted by the average probability of MCO policyholders ($\tilde{\theta}/2$).

$$P_I = \frac{\tilde{\theta}}{2} c. \tag{7}$$

The equilibrium in the sub-game at the downstream level can be directly derived from the marginal policyholder definition and premiums. For a given price R, the health insurance sector equilibrium is given by:

$$\begin{aligned} P_{NI} &= \frac{1}{2} R \left(1 + \frac{2KR}{2cK - 2KR + (K-1)t}\right), \\ P_I &= \frac{cKR}{2cK - 2KR + (K-1)t}, \\ \tilde{\theta} &= \frac{2KR}{2cK - 2KR + (K-1)t}. \end{aligned}$$

[11] We implicitly assume a communauty rating regime in the sense that premiums reflect the average risk of policy holders affiliated to the same type of insurers. This assumption is natural according to the large market share of collective health insurance contracts in United States.

Remark: At this stage, both premiums increase in the wholesale price R.

Proof. Straightforward. ■

Ceteris paribus, *i.e.* at the given risk segmentation, an increase in the wholesale price increases the premium of conventional insurers. Consequently, MCOs become more attractive, in turn reinforcing the risk segmentation effect ($\tilde{\theta}$ increases in R). Both premiums increase in R.

3.2 Upstream Competition

Only a fraction $(1-\tilde{\theta})$ of policyholders choose their providers freely. Then, according to the *ex post* uniform distribution address, when contracts between insurers and providers are non-exclusive, each provider is actually in a monopolistic competition context where they must deal with a demand[12] equal to $\left(1-\tilde{\theta}^2\right)/2K$. Therefore, each provider j seeks to maximize[13]

$$\underset{R_j}{Max}\Pi = (R_j - c)\left(\frac{1-\tilde{\theta}^2(R)}{2K}\right),$$

where R is the average price paid to physicians.[14] The first-order condition gives:

$$\frac{\tilde{\theta}}{K}\frac{\partial\tilde{\theta}(R)}{\partial R}(R_j - c) = \frac{1-\tilde{\theta}^2(R)}{2} \tag{8}$$

that can also be written:

$$\frac{R^* - c}{R^*} = \frac{1-\tilde{\theta}^2}{2\tilde{\theta}^2}\frac{K}{\mu} \tag{9}$$

where μ represents the elasticity of the marginal policyholder with respect to the average price paid to physicians and R^* denotes the price charged by providers at the symmetric equilibrium of this sub-game.[15]

[12] It is due to the fact that the market share of conventional insurers is $1-\tilde{\theta}$, the average risk of policyholders choosing this solution is $\left(1+\tilde{\theta}\right)/2$ and patients are uniformly distributed over the circle where J providers are available.

[13] We can easily check that second-order conditions are satisfied.

[14] We have $R = \sum^{J} R_j/K$. In this case, according to the uniform distribution of physicians, they obtain identical market shares. Consequently, the average is a non-weighted sum.

[15] $\mu = \frac{\partial\tilde{\theta}(R^*)}{\partial R}\frac{R^*}{\tilde{\theta}}$.

Proposition 1 *In equilibrium, the physicians' mark-up directly*[16]*:*

i) increases with the number of physicians available for conventional insurers' policyholders;

ii) decreases with the elasticity of the wholesale price.

Proof. Straightforward from (9). ■

The equation (9) looks like the traditional formula obtained in Cournot's oligopoly framework in the sense that the physicians' mark-up is inversely related to the price elasticity. Nevertheless, significant differences may be noticed. The first point of the Proposition 1 (with respect to the number of physicians) may be interpreted as an induced demand effect from providers when their control variable is price and not quantity.[17] When the number of providers increases, the diversity supplied by conventional insurers also increases. *Ceteris paribus*, their demand function shifts upwards, so the number of policyholders who can freely choose their provider is increased, thus allowing providers to increase their mark-up. Actually, a positive externality occurs between physicians due to the effect on the conventional insurer demand. When the marginal policyholder is extremely price sensitive, this demand effect obviously reduces the physicians' ability to increase their mark-up. Nevertheless, this positive externality is weaker than the competition effect coming from the number of providers, as shown in the following Proposition 2.

Proposition 2 *If an interior equilibrium occurs i.e.* $\tilde{\theta} < 1$*, the profit of the providers is decreasing with* K *(is increasing in* n*).*

Proof. See Appendix. ■

Under our specifications, the Proposition 2 points out that the competition effect dominates the mark-up effect. We now turn to the analysis of our equilibrium's properties.

3.3 Properties of the equilibrium

Instead of directly analyzing variations of R and $\tilde{\theta}$ with respect to K, the MCO market share variation with respect to K can be understood thanks to the following decomposition:

μ.

[16] We specify that it is a direct effect because the number of physicians also clearly appears in $\tilde{\theta}$ and in the price elasticity

[17] See Rice and Label (1989) for an explanation of the induced demand effect.

$$\frac{d\tilde{\theta}}{dK} = \frac{\partial\tilde{\theta}}{\partial K} + \frac{\partial\tilde{\theta}}{\partial R}\frac{\partial R}{\partial K} \tag{10}$$

The first term is called the *direct or diversity effe*ct and is a direct consequence of the risk segmentation. We have already described it previously: if conventional insurers supplied more diversity (in terms of providers available), then the MCOs' market share decreases. The second term is named the *indirect or price effect.* It captures the impact of the health care price paid by conventional insurers to physicians on the existing risk segmentation. Hence, the higher the price paid by conventional insurers to providers, the higher the premium charged by insurers to their policyholders and the lower their market share.

Remark 1 *If the MCO market share increases with K, then R also increases with respect to K (decreases with respect to n).*

As $\tilde{\theta}$ decreases with respect to R while the direct effect means that $\partial\tilde{\theta}/\partial K < 0$, we have $d\tilde{\theta}/dK > 0$, if and only if $\partial R/\partial K > 0$. In the appendix, we define a threshold value for c allowing us to give the following Proposition 3:

Proposition 3 *The MCO market share increases with K (decrease with n) if and only if $c < \widetilde{c}(t, K)$.*

Proof: See appendix.

We have two countervailing effects at work: the price and the diversity (or segmentation) effects previously mentioned. In equilibrium, for small values of c, we show that the MCO market share increases with the number of physicians available in the market. In other words, when the health care marginal cost is low enough, instead of losing market shares because the diversity supplied by conventional insurers increases and makes them more attractive, MCO market share increases because providers charged a higher price to conventional insurers who are obliged to increase the premiums to their policyholders. As MCOs obtain health care at its marginal cost, the difference $P_{NI} - P_I$ increases such that it dominates the increase of the diversity supplied by conventional insurers.

Based on the Remark 1 and Proposition 3, we can summarize the result obtained in the following corollary:

Corollary 1 *For small values of c (i.e. $c < \widetilde{c}(t, K)$), R, P_{NI} and P_I are increasing in K and decreasing in n.*

Variations of premium P_{NI} become intuitive: In equilibrium, for small values of c, $\tilde{\theta}$ and R increase in K. As conventional insurers' premiums increase with R and $\tilde{\theta}$, P_{NI} also increases with K and decreases with the number of vertical integrations (n). This corollary reveals that when the level of the health care marginal cost is low enough, an increase in the number of providers, *i.e.* an increase in the diversity supplied by conventional insurers, is Pareto-improving. Indeed, in such a case, the surplus of policyholders increases, independent from the type of health insurers they have chosen.[18] Moreover, for a given number of providers, the presence of additional MCOs implies that the number of free providers is reduced. When the price of health care increases with the number of providers available, it decreases with the number of MCOs. The Proposition 3 reveals the tradeoff in the case of exclusive contracts between transportation costs due to MCOs and the fact that the mark-up of providers may decrease with the number of MCOs (for $c < \widetilde{c}$). Actually, competition between MCOs and conventional insurers generates two inefficiencies: a wholesale price above the marginal cost and transportation costs generated by *ex post* differentiation. In the literature dealing with vertical integration, the main issue under analysis is the occurrence of some "*raise rivals' cost*" effects. It is usually assumed that vertical integrations reduce the number of health care providers, and therefore increase the wholesale price and then the conventional insurers' premiums. In our framework, the nature of the relationship between vertical restraints and "*the rivals' cost*" is different. Vertical integrations reduce the number of providers, therefore decreasing the diversity generated by conventional insurers. Nevertheless, for $c < \widetilde{c}$, the reduction in diversity also decreases the wholesale price through the indirect price effect, which *ceteris paribus*, reduces the conventional insurers' costs. Therefore, for a low health care marginal cost, our results are exactly opposite to the so-called "*raise rivals' cost*" effect. The greater the number of vertical restrictions, the more the conventional insurers' marginal cost, and consequently their premiums, decrease.

Most of the time, the negative correlation between conventional insurance premiums and the MCO penetration is explained by the increasing competition in the health insurance sector.[19] In this paper, without taking into account this possible effect, our results indicate that conventional insurance premiums may decrease with the number of MCOs when they sign exclusive contracts with providers. Our result also allows us to shed light on the ambiguous evidence obtained in the literature about vertical integration's consequences in the health sector (Gaynor, 2006). Roughly speaking, we point out that the health care marginal cost may be part of the different results obtained by empirical studies dealing with vertical integration and exclusive contracts in the health care sector.

[18] Remember that due to our assumption of perfect competition in the health insurance sector, insurers' profit remain equal to 0.

[19] See for example Baker and Corts (1996).

4 Conclusion

This model attempts to analyze the impact of vertical integrations in the health insurance sector. As in Gaynor (2006) for health care markets, our results indicate that there is no definitive or unconditional conclusion concerning vertical integration consequences in health insurance markets. Nevertheless, our framework identifies some market structure parameters that can influence vertical integration effects. More precisely, our model reveals that the so-called *raise-rival cost* effect only occurs for a specific range of health care marginal costs. For smaller values, vertical integration can paradoxically lead to a reduction of conventional insurance premiums. For practical purposes, it may be too difficult to estimate the threshold value of the health care marginal cost. Our model suggests that the elasticity of the MCO market share should be estimated with respect to the number of physicians in order to determine the vertical integration consequences.

This model could be extended in several ways. First, it could be interesting to pay attention to the situation where some of the health insurers are public or not for profit (see Cremer *et al.*, 1991). Second, we have assumed that the market is covered on the policyholders' side which is not necessarily the case in practice. Therefore, our model could be modified to have an uncovered market and to introduce an universal service issue as it is the case in other sectors (see Cremer *et al.*, 2001). Finally, it is worth noticing that even though our set up is devoted to the analysis of vertical integration in health insurance sector, it could be applied to all other sectors in which vertical restraints imply a reduction of the products diversity and that there exist sufficient heterogeneity among consumers with respect to diversity valuation. In such a case, our model should be slightly modified to take into account that the consumers' willingness to pay does not necessarily follow a probability structure.

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5 Appendix

5.1 Proof of Proposition 2

The comparative static of the provider profit function is given by

$$\frac{d\Pi}{dK} = \frac{\partial \Pi}{\partial R}\frac{dR}{dK} + \frac{\partial \Pi}{\partial K}$$

The envelope theorem implies that $\frac{\partial \Pi}{\partial R} = 0$. So

$$\frac{d\Pi}{dK} = \frac{\partial}{\partial K}\left(\frac{1-\tilde{\theta}^2(R,K)}{2K}\right) \equiv \Gamma(K)$$

with

$$\Gamma(K,t,c,R) = -1 + \frac{4K^2R^2\left(t + K\left(2c - 2R + t\right)\right)}{\left(2cK - 2KR + (K-1)t\right)^3}.$$

Then, the goal of the proof is to sign $\Gamma(K)$ (the sign of $d\Pi/dK$ being the same). It is worth noticing that for $t = 0$, we have

$$\Gamma(K, t = 0, c, R) = -8cK^3\left(c - 2R\right)\left(c - R\right) < 0.$$

Moreover, the function $\Gamma(K,t,c,R)$ is decreasing in t if and only if

$$\frac{\partial \Gamma(K,t,c,R)}{\partial t} = 4K^2(1+K)R^2 - 3\left(K-1\right)\left(2cK - 2KR + (K-1)t\right)^2 \leq 0.$$

In the case of an interior equilibrium, we have $\tilde{\theta} < 1$. Taking into account that

$$\tilde{\theta} = \frac{2KR}{2cK - 2KR + (K-1)t},$$

we have

$$\begin{aligned} \tilde{\theta} &< 1 \Leftrightarrow 2cK - 2KR + (K-1)t > 2KR \\ &\Leftrightarrow \left(2cK - 2KR + (K-1)t\right)^2 > \left(2KR\right)^2. \end{aligned}$$

The previous inequality associated with the condition $K \geq 2$ implies that

$$4K^2(1+K)R^2 < 3\left(K-1\right)\left(2cK - 2KR + (K-1)t\right)^2,$$

so that

$$\frac{\partial \Gamma(K,t,c,R)}{\partial t} < 0.$$

As $\Gamma(K, t = 0, c, R) < 0$ and the function $\Gamma(.)$ is decreasing in t, we have $\Gamma(K,t,c,R) < 0$ that prove $d\Pi/dK < 0. Q.E.D.$

5.2 Proof of Proposition 3

We find some conditions for R to insure that θ increases with respect to K. We are able to exhibit some values of the parameters (c, t) for which these conditions are checked in equilibrium (with $R = R^*$).

Our proof is performed in four steps. First (1), we determine the general condition enabling the HMOs' market share to increase with respect to K. Second (2), we determine the conditions for parameter c such that θ increases or decreases with respect to K. Third (3), we show that for $R > c$, the HMOs' market share can increase or decrease with respect to K. In the last step (4), on the basis of (1), (2) and (3), we define the variations of θ in equilibrium (with $R = R^*$). According to (1),(2), (3) and (4), we can conclude that the HMOs' market share increases with respect to K if c is sufficiently low.

(1) If equilibrium is obtained in the sub-game, the marginal policyholder is defined by:

$$\theta(K, R) = \frac{2KR}{(2cK - 2KR + (K-1)t)}$$

The maximization of each provider's profit enables to determine price R^* which is paid by insurers:

$$R^*(K) = \frac{6cK^2 + 3tK^2 - 3tK - 4cK - H}{8K(K-1)} \tag{11}$$

$$\text{with } H = \sqrt{4c^2(K-2)^2K^2 + 4cK^2\left(K^2 + K - 2\right)t + K(K-1)^2(8+K)t^2}.$$

We can determine the HMO's market share $\theta(J) = \theta(K, R(K))$ and study the variation of $\theta(K, R(K))$ with respect to K. The differentiation of θ with respect to K leads to the following expression:

$$\frac{d\theta}{dK} = \frac{\partial\theta}{\partial K} + \frac{\partial\theta}{\partial R}\frac{dR^*(K)}{dK}.$$

Then θ increases with respect to K if and only if

$$\frac{\partial\theta}{\partial K} + \frac{\partial\theta}{\partial R}\frac{dR^*(K)}{dK} > 0$$

which is equivalent to:

$$\frac{R^{*'}(K)K}{R^*(K)} > \frac{t}{2cK + tK - t}$$

If we consider the following function $f(R^*, c, t, K)$ such as:

$$f(R^*, c, t, K) = \frac{R^{*\prime}(K)K}{R^*(K)} - \frac{t}{2cK + tK - t} \tag{12}$$

Then, the previous condition basically becomes $f(R^*, c, t, K) > 0$.

Due to the fact that the price paid by insurers is given by (11), we can derive this price by K and substitute the square term by H. Then, we obtain the following expression:

$$R'(K) = \frac{3tK^3c + 2K^3t^2 - 2c^2K^3 - 6t^2K^2 + 6t^2K - 2t^2 + 4c^2K^2 - 3cK^2t - cKH}{4KH\left(K-1\right)^2}. \tag{13}$$

From (11), by writing H as a function of R, we obtain:

$$H = K\left(-3t - 4c + 6cK + 3tK - 8RK + 8R\right) \tag{14}$$

combining (14) with (13), (12) becomes:

$$f(R^*, c, t, K) = \frac{N(R^*)}{2H\left(K-1\right)R^*\left(cK + tK - t\right)},$$

where

$$\begin{aligned} N(R^*) \quad = \quad & 16tK\left(K-1\right)^2 R^{*2} - 2K\left(3t\left(K-1\right)^2\left(3t+4c\right) - 4c^2K^2\right)R^* \\ & + \left(K-1\right)t(\left(K-1\right)^2 t^2 + 2Kct(K-1) - 4K^2c^2) - 8c^3K^3. \end{aligned}$$

As the denominator of $f(R^*, c, t, K)$ is always positive, we can focus on the sign of the numerator $N(R^*, c, t, K)$.

(2) At this stage, we study the function $N(R)$ to determine if $f(R, c, t, K)$ is positive or negative. Due to the complexity of the expressions, we proceed in two steps: first, we study the function N with respect to R. Second, we determine the sign of N at R^*.

If we note Δ the discriminant of function $N(R)$, we can easily show that $N(R)$ has one or two solutions. The study of Δ with respect to c shows that:

$$\Delta|_{c=0} < 0 \text{ and } \left.\frac{\partial \Delta}{\partial c}\right|_{c=0} < 0.$$

Moreover Δ is convex with c because:

$$\frac{\partial^2 \Delta(c)}{\partial c^2} = 64K^2\left(7K^2 - 12K + 2\right)\left(K-1\right)^2 t^2 + 2304K^4\left(K-1\right)^2 ct + 768K^6c^2 > 0.$$

We can conclude that there exists a value of c, noted $\widetilde{c}(t, K)$, such that $\Delta|_{\widetilde{c}(t,K)} = 0$. If $c < \widetilde{c}(t, K)$ then $\Delta < 0$ *(i)*, and otherwise $\Delta > 0$ *(ii)*. It is clear that in the first case *(i)*, $N(R)$ is always positive (in particular with $R = R^*$) and we can conclude that $\partial\theta/\partial K > 0$.

In the second case (ii), $N(R)$ has two solutions noted $R^{'}$ and $R^{''}$, such that $N(R^{'}) = N(R^{''}) = 0$. Moreover, as

$$\frac{\partial^2 N}{\partial R^2} = 32t(K-1)^2 > 0,$$

we conclude that function $N(R)$ is negative when $R^{'} < R < R^{''}$.

In order to define whether $N(R = R^*)$ is positive or negative, when $c \geq \widetilde{c}(t, K)$, and if, in equilibrium, the MCOs' market share increases or decreases with respect to K, we must compare $R^{'}$ and c (see (3)), and $R^{''}$ and R^* (see (4)).

(3) Comparison of $R^{'}$ and c.

We have:

$$(R^{'} - c) = -\frac{[Z + \sqrt{x}]}{16tK(K-1)^2},$$

with

$$Z(c) = 4K^3c^2 + 3Kt(4c - t)\left(1 - K\right)^2,$$

and

$$\begin{aligned} x \quad = \quad & (K-1)^2\left(-K\left(7K-16\right)\left(K-1\right)^2 t^4 - 8K^2\left(K-1\right)^2 ct^3\right. \\ & \left. +8K^2\left(7K^2 - 12K + 2\right)c^2t^2 + 96c^3K^4t\right) + 16c^4K^6. \end{aligned}$$

Function $Z(c)$ has two solutions: the first-one is negative whereas the second-one is equal to:

$$\overline{\overline{c}}(t, K) = \frac{-12K + 12 + 4\sqrt{12K^2 - 18K + 9}}{8K^2}(K-1)t.$$

It is worth noting that $Z(c = 0) < 0$, then

$$Z(c) < 0 \text{ if } c < \overline{\overline{c}} \text{ and } Z(c) \geq 0 \text{ if } c \geq \overline{\overline{c}}(t, K).$$

It should be noted that if $\Delta|_{c=\overline{\overline{c}}} < 0$, we have: $\widetilde{c}(t, K) > \overline{\overline{c}}(t, K)$ and $R^{'} < c$ if $c > \widetilde{c}(t, K)$.

(4) Comparison of $R^{''}$ and R^*.

After straightforward but tedious calculous, we show that:

$$R^{''} > R^* \; if \; c < \widetilde{\widetilde{c}}(t, K),$$

where:

$$\widetilde{\widetilde{c}}(t,K) = \left(\frac{G}{6K\left(2+K^2-2K\right)} + \frac{31K+4K^3-16K^2-24}{6\left(2+K^2-2K\right)G} - \frac{K+1}{6\left(2+K^2-2K\right)} \right) t\left(K-1\right)$$

and

$$G = \sqrt[3]{\left(141K^3+8K^5-48K^4-226K^2+198K-54+3\sqrt{3}(2+K^2-2K)\sqrt{7K^2-16K+27}\right)K}.$$

Finally, we show that if $\widetilde{\widetilde{c}}(t,K) < \widetilde{c}(t,K)$, then $R^{''} > R^*$ is always true when $c \geq \widetilde{c}(t,K)$.