A comparison of ambulatory health care systems (First draft)

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Abstract

In this presentation we compare two ambulatory health care organisations from a theoretical point of view. The first one is a non-gatekeeping system which allows patients to have a free access to specialty care. In this organisation both physicians are paid under fee-for-service (FFS). The second organisation is a gatekeeping system: a GP referral is compulsory to get to specialty care. We suppose that GPs and specialists remain reimbursed under FFS, as in Preferred Providers Organisations. We assume that GPs are less trained that specialists and the insurer acts à la Laffont and Tirole (1993). The payment schemes of both physicians are computed to maximise the expected utility he perceived of the treatment minus its social costs. We assume that the insurer observes neither the diagnosis effort nor the treatment carried out by GPs. In the different health care systems we compute the payments schemes of both physicians which maximise the expected utility and satisfy the incentive and participative constraints. We compute the utility of the health insurer under these optimal contracts. Using these utilities we compare the two health care systems. We conclude that in PPOs treatment costs are not necessarily lower than in the non gatekeeping system. But the expected utility may be higher in the non gatekeeping system.

Keywords: non gatekeeping; gatekeeping; fee-for-service
JEL classification: D82, I18, L51

1 Introduction

Since the end of the 70s, developed countries have been facing increasing ambulatory and secondary health care expenditures. Reforms aiming at curbing ambulatory expenditures have been implemented only since the beginning of the 1990s.

These reforms depended on the prior health care organisation:

- in the UK GPs gatekeepers became fundholders,
- in Germany and in the Netherlands competition between insurers have been increased,
- in France since the reform which capped GPs' FFS fail to curb expenditures, GPs have become gatekeepers.

In this article we compare two health care organisations:

- the first one was found in France prior the health care reform of 2004 and in traditional insurance: GPs and specialists are paid under FFS and patients have a free access to specialty care,

- the second one is the current French ambulatory health care system and the Preferred Providers Organisations: GPs and specialists remain paid under FFS, but GPs are gatekeepers.

This paper is organised as follow. In the first section we give the hypotheses of the different health care systems. In the second part we compute the expected utilities and the optimal health care payment of both physicians. We suppose that insurers impose neither the diagnosis effort nor the treatment carried out by the GPs. In the last section we compare these two organisations. All our results are summed up in the conclusion.

2 The model

In this section we present the assumptions about patients', physicians' and insurers' behaviours. It enables us to take into account the main features of both health care systems.

2.1 Patients

We assume that the patient suffers from a mild or a severe illness which occur with the same probability[1].

We define two events:

- the patient suffers from a minor illness by m,
- the patient suffers from a severe illness by s,

and we obtain the following probabilities:

$$\Pr(s) = \Pr(m) = \frac{1}{2}$$

We suppose that:

- the minor illness is cured with m health care services which can be carried out by GPs and specialists,
- the severe illness is cured with s health care services only supplied by specialists, with $s > m$.

We define two events:

- the patient consults the GP by CG,
- the patient consults the specialist by CS.

In a health care organisation with free access to specialty care we suppose that the patient does not observes his illness. He chooses his physician randomly. Thus the consulting probabilities are:

$$\Pr(CG) = p, \Pr(CS) = 1 - p$$

with $p > \frac{1}{2}$, it is more likely that a suffering patient consults a GP than a specialist.

In the gatekeeping system, since the patient must consult his GP. The probabilities become:

$$\Pr(CG) = 1, \Pr(CS) = 0$$

2.2 Physicians

As both GPs and specialists produce ambulatory health care services we must take into account both types of physician, i.e.:

- their payment schemes,
- their knowledge and ability to treat the different kinds of illness.

[1] Unlike Bardey (2002), severity must be understood as different levels of a given illness (bacterial or viral sore throat for instance). This probability is common knowledge.

2.2.1 Specialists

Specialists have a deeper knowledge of both illnesses:

- they cure both kinds of illness and always treat his patient,
- they observe perfectly the illness of his patient and do not perform any diagnosis effort.

As specialists use high-tech equipment to treat illnesses we suppose they bear the treatment costs:

- if they treat a minor illness they support a cost c_1
- if they treat a patient suffering from a severe illness they support a cost c_2, if the patient did not received a treatment before[2] or c_3 if the patient was treated unsuccessfully by his GP.

We suppose that $c_3 > c_2 > c_1$[3].

If p_s is the fee for one service, their revenues are:

- $p_s(m+1) - c_1$ if they treat a minor illness,
- $p_s(s+1) - c_2$, if they treat a patient who is actually suffering from a severe disease and was referred by his GP or has a direct access to specialty care,
- $p_s(s+1) - c_3$, if they treat a patient who is actually suffering from a severe disease and was treated unsuccessfully before by his GP.

In both organizations specialists have a reservation wage ω_s with $\omega_s > \omega_g$.

2.2.2 GPs

Unlike specialists, GPs do not know exactly the illness of his patient. Moreover they are trained to treat the mild disease. It means that:

- GPs can not heal a patient suffering from the severe illness,
- they treat the mild illness at no cost,
- when a patient consults GPs they do not know if he suffers from a mild or a severe disease: to improve their knowledge they perform a diagnosis effort.

As in Jelovac (2001) we suppose that during the first consultation GPs carry out a diagnosis effort $e \in [0,1]$:

- this effort gives him a signal s^g on the illness of his patient,
- the signal is either $s^g = s$ (i.e. the patient suffers from a severe illness) or $s^g = m$ (i.e. the patient suffers from a minor illness).

We suppose that the higher the effort is, the sharper the signal is:

$$\Pr(s^g = s/s) = \Pr(s^g = m/m) = \frac{1+e}{2}$$

- GPs bear a disutility, $\Psi(e) = k\frac{e^2}{2}$ with $k > 0$.

Once the signal observed the GP chooses either to treat his patient or to refer him to a specialist.

We suppose that patients suffering from a severe illness leave GPs who decided to treat them. It means that GPs suffer a loss of reputation r, with $r > p_g m$.

Finally we assume that GPs have a reservation wage ω_g, with $\omega_g < \omega_s$.

If p_g is the fee for one service, the revenues of GPs are:

- $p_g(m+1)$, if they treat a patient suffering from a minor illness,
- p_g, if they referred him to specialty care.

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[2] It is the case when patient consults a specialist or when the GP refers him.

[3] When a patient suffering from a severe illness is referred too late to a specialist he must perform a deeper and costlier treatment, i.e. $c_3 > c_2$. Moreover it is more costly to treat a severe illness, i.e. $c_2 > c_1$.

2.3 The insurer

We suppose an insurer à la Laffont and Tirole (1993). His objective is to maximise social welfare and give the same weight to patient's utility and physicians' profits, taking into account the social cost of public funding λ.

As in procurement model the insurer takes into account the utility of the patient following the treatment. This utility depends on the timing of the game:

- if the patient is cured after one consultation the insurer assumes his utility is U_1,
- if the patient is cured after two consultations, i.e. the GP does not treat him and refers him to a specialist, the utility is U_2,
- if the patient is cured after two consultations, but the GP treats him before, the insurer assumes his utility is U_3,

with $U_1 > U_2 > U_3$.

The payments of physicians depend on the treatment carried out. The health insurer gives:

- $p_g(m+1)$ or p_g to GPs,
- $p_s(s+1)$, $p_s(s+1)$ or $p_s(m+1)$ to specialists.

In this paper, we focus on the imperfect information case, i.e. the insurer can impose neither the diagnosis effort nor the treatment carried out by GPs.

Our assumptions differ from the ones assumed in Marinoso and Jelovac (2003) and in Levaggi and Rochaix (2007):

- in the first paper, in the gatekeeping and non gatekeeping systems which are compared the payment scheme of GPs is based on three components. By contrast we assume that GPs are paid under FFS because we want to compare the actual health care systems,
- in the second paper, the actual payment scheme is taken into account. But these payments are exogenous whereas in our model they are endogenous.

3 Expected utilities in both health care systems

Before performing his diagnosis, the GP knows that both illnesses occur with the same probability and that patient chooses his physician randomly.

Updating their belief with the Bayes rules, a GP diagnoses accurately a minor or a severe illness with the following probability:

$$p(s/s^g = s) = p(m/s^g = m) = \frac{1+e}{2}$$

and

$$p(s/s^g = m) = p(m/s^g = s) = \frac{1-e}{2}$$

We can compute for both health care organisations the expected utility of GPs U_g, the expected utility of specialists U_s and the expected utility of insurer U_r.

We limit ourselves to three treatment strategies. GPs can:

- always treat their patient,
- always refer them,
- treat them if they diagnose a mild disease[4].

[4] This last treatment strategy is called the appropriate strategy.

3.1 In a non gatekeeping system

If GPs have a financial incentive to always treat their patient, their expected utility is:

$$U_g^{1\prime} = p\left(p_g(m+1) - k\frac{e^2}{2} - \frac{r}{2}\right)$$

The expected utilities of specialists and of the health insurer are:

$$U_s^{1\prime} = p_s\left[\frac{(s+1)}{2} + \frac{(1-p)(m+1)}{2}\right] - \left(\frac{(1-p)}{2}(c_1+c_2) + \frac{p}{2}c_3\right)$$

and

$$\begin{aligned} U_r^{1\prime} &= U_1(1-\frac{p}{2}) + U_3\frac{p}{2} - \left(\left(\frac{1-p}{2}\right)(c_1+c_2) + \frac{p}{2}c_3\right) \\ &-\lambda p_s\left[\frac{(s+1)}{2} + \frac{(1-p)(m+1)}{2}\right] - p\left(\lambda p_g(m+1) + k\frac{e^2}{2} + \frac{r}{2}\right) \end{aligned}$$

If GPs have a financial incentive to always refer their patient, their expected utility is:

$$U_g^{2\prime} = p\left(p_g - k\frac{e^2}{2}\right)$$

The expected utilities of specialists and of the insurer are:

$$U_s^{2\prime} = p_s\left[\frac{(s+1)}{2} + \frac{(m+1)}{2}\right] - \frac{1}{2}(c_1+c_2)$$

and

$$\begin{aligned} U_r^{2\prime} &= U_1(1-p) + pU_2 - \frac{1}{2}(c_1+c_2) \\ &-\lambda p_s\left[\frac{(s+1)}{2} + \frac{(m+1)}{2}\right] - p\left(\lambda p_g - k\frac{e^2}{2}\right) \end{aligned}$$

If GPs have a financial incentive to treat their patient only when they diagnose a mild illness, their expected utility is:

$$U_g^{3\prime} = \left(\frac{p}{2}\right)(p_g(m+2)) - p\frac{ke^2}{2} - r\frac{p(1-e)}{4}$$

The expected utility of secondary health care providers is:

$$\begin{aligned} U_s^{3\prime} &= p_s\left[\frac{(s+1)}{2} + \frac{(m+1)}{2}\left(1-p+\frac{p(1-e)}{2}\right)\right] \\ &-\left(\frac{(1-p)}{2}(c_1+c_2) + \frac{p}{4}\left((1-e)(c_1+c_3) + (1+e)c_2\right)\right) \end{aligned}$$

The expected utility of the health care insurer is:

$$
\begin{aligned}
U_r^{3\prime} &= U_1\left(1-p+\frac{p(1+e)}{4}\right)+U_2\left(\frac{p}{2}\right)+\frac{p(1-e)}{4}U_3 \\
- & p\frac{ke^2}{2}-r\frac{p(1-e)}{4} \\
- & \lambda\left(\frac{p}{2}\right)p_g\,(m+2) \\
- & \lambda p_s\left[\frac{(s+1)}{2}+\frac{(m+1)}{2}\left(1-p+\frac{p(1-e)}{2}\right)\right] \\
- & \left(\frac{(1-p)}{2}\,(c_1+c_2)+\frac{p}{4}\,((1-e)\,(c_1+c_3)+(1+e)\,c_2)\right)
\end{aligned}
$$

3.1.1 In a gatekeeping system

Since both physicians are paid under FFS in both organisations only the probabilities of consulting GPs change. By replacing p with 1, we get the expected utilities in this gatekeeping system.

If GPs have a financial incentive to always treat their patient, the expected utilities become:

$$
U_g^{1\prime\prime} = p_g(m+1)-k\frac{e^2}{2}-\frac{r}{2}
$$

$$
U_s^{1\prime\prime} = \frac{1}{2}\,(p_s(s+1)-c_3)
$$

$$
\begin{aligned}
U_r^{1\prime\prime} &= \frac{1}{2}\,(U_1+U_3)-\frac{(1+\lambda)}{2}c_3 \\
&-\lambda p_s\frac{(s+1)}{2}-\left(\lambda p_g(m+1)+k\frac{e^2}{2}+\frac{r}{2}\right)
\end{aligned}
$$

If GPs have a financial incentive to always refer their patient, the expected utilities are:

$$
U_g^{2\prime\prime} = p_g-k\frac{e^2}{2}
$$

$$
U_s^{2\prime\prime} = p_s\left[\frac{(s+1)}{2}+\frac{(m+1)}{2}\right]-\frac{1}{2}\,(c_1+c_2)
$$

$$
U_r^{2\prime\prime} = U_2-\frac{(1+\lambda)}{2}(c_1+c_2)-\lambda p_s\left[\frac{(s+1)}{2}+\frac{(m+1)}{2}\right]-\lambda p_g-k\frac{e^2}{2}
$$

If GPs have a financial incentive to treat their patient only when they diagnose a mild illness, the expected utilities are:

$$
U_g^{3\prime\prime} = \left(\frac{1}{2}\right)(p_g\,(m+2))-k\frac{e^2}{2}-r\frac{(1-e)}{4}
$$

$$
\begin{aligned}
U_s^{3\prime\prime} &= p_s\left[\frac{(s+1)}{2}+\frac{(m+1)}{2}\left(\frac{(1-e)}{2}\right)\right] \\
&-\left(\frac{1}{4}\,((1-e)\,(c_1+c_3)+(1+e)\,c_2)\right)
\end{aligned}
$$

$$
\begin{aligned}
& U_r^{3\prime\prime} = U_1\left(\frac{(1+e)}{4}\right) + U_2\left(\frac{1}{2}\right) + \frac{(1-e)}{4}U_3 \\
& -k\frac{e^2}{2} - r\frac{(1-e)}{4} \\
- \quad & \lambda\left(\frac{1}{2}\right)p_g\,(m+2) \\
- \quad & \lambda p_s\left[\frac{(s+1)}{2} + \frac{(m+1)}{2}\left(\frac{(1-e)}{2}\right)\right] \\
- \quad & (1+\lambda)\left(\left(\frac{(1-e)}{4}\right)c_1 + \left(\frac{(1+e)}{4}\right)c_2 + \frac{(1-e)}{4}c_3\right)
\end{aligned}
$$

4 Second best contracts

In this section we compute second best contracts. We first determine the level of effort and the treatment carried out by GPs. Then we compute incentives constraints and finally second best payment schemes.

4.1 The treatment implemented

In this section we compute in both health care systems the condition under which GPs:

- always treat their patient,
- always refer them,
- treat their patient if they diagnose a mild disease.

4.1.1 In a non-gatekeeping system

When GPs diagnose a severe illness, i.e. $s^g = s$, they can decide to treat their patient. If he suffers from a mild disease, which occurs with the probability $p(m/s^g = s)$, GPs get $p_g(m+1)$. If he suffers from the severe mild illness, which occurs with the probability $p(s/s^g = s)$, the treatment of GPs is useless. Since the patient shifts GPs, they bear a loss of reputation, and their utility is $p_g(m+1) - r$. GPs can also decide to refer their patient. In such a case their payment is p_g, whatever the severity of the illness.

When GPs diagnose a mild illness, i.e. $s^g = m$, they first can decide to treat their patient. If he suffers from a mild disease, which occurs with the probability $p(m/s^g = m)$, the payment of GPs is $p_g(m+1)$. If he suffers from the severe mild illness, which occurs with the probability $p(s/s^g = m)$, the treatment of GPs is useless. Since the patient shifts GPs, they bear a loss of reputation, and their utility is $p_g(m+1) - r$. GPs can also decide to refer their patient. In such a case their payment is p_g, whatever the severity of the illness.

Since all updated probabilities do not depend on p, we have the same lemmas for both health care organisations.

Lemma 1 *A primary health care provider who diagnoses a mild illness treats his patient instead of referring him, if:*

$$p(s/s^g = m)(p_g(m+1) - r) + p(m/s^g = m)p_g(m+1) \geq p_g$$

$\iff$

$$e \geq \frac{r - 2p_g m}{r} \equiv \hat{e}'$$

Lemma 2 *A primary health care provider who diagnoses a severe illness refers his patient instead of treating him, if:*

$$p_g \geq p(s/s^g = s)(p_g(m+1) - r) + p(m/s^g = s)p_g(m+1)$$

$\iff$

$$e \geq \frac{2p_g m - r}{r} \equiv -\hat{e}'$$

Since e is a probability, we must take into account that $e \in [0,1]$. The following lemma sums up the different treatment strategies under this constraint.

Lemma 3 *The treatments carried out by GPs are the following ones:*
i) if $r - 2p_g m > 0$, then there are two cases. If the level of effort is low, i.e. $e \in [0, \hat{e}')$, then GPs always refer their patient. If the level of effort is high, i.e. $e \in (\hat{e}', 1]$, then GPs treat their patient only when a mild illness is diagnosed,
ii) if $-r + 2p_g m > 0$, then there are two cases. If the level of effort is low, i.e. $e \in [0, -\hat{e}')$, then GPs always treat their patient. If the level of effort is high, i.e. $e \in (-\hat{e}', 1]$, then GPs treat their patient only when a mild illness is diagnosed.

In the following section we compute the level of diagnosis effort for each treatment strategy and for both organisations.

4.2 The diagnosis effort

Following the previous lemmas we know that the diagnosis efforts depend only on the treatment.

Lemma 4 *If a primary health care provider always treats or always refers his patient, the optimal level of effort is: $e^{1\prime} = e^{2\prime} = e^{1\prime\prime} = e^{2\prime\prime} = 0$*
and their expected utilities are:

$$U_g^{1\prime} = p\left(p_g(m+1) - \frac{r}{2}\right)$$
$$U_g^{2\prime} = pp_g$$

in the non gatekeeping system and,

$$U_g^{1\prime\prime} = p_g(m+1) - \frac{r}{2}$$
$$U_g^{2\prime\prime} = p_g$$

in the gatekeeping system.

This result is intuitive. Since GPs implement a blind strategy of treatment carrying out an effort is costly and useless. The best level of effort is the lowest one.

Lemma 5 *If GPs treat their patient only when they diagnose a mild disease, the optimal level of diagnosis effort is:*

$$e^{3\prime} = e^{3\prime\prime} = min\{max\{\frac{r}{4k}, \varepsilon'\}, 1\}$$

with

$$\varepsilon' = \max\{\hat{e}', -\hat{e}'\} = \frac{\mid 2p_g m - r \mid}{r}$$

and their expected utilities are:

$$U_g^{3\prime} = \left(\frac{p}{2}\right)(p_g\,(m+2)) - pk\frac{(e^{3\prime})^2}{2} - r\frac{p(1-e^{3\prime})}{4}$$

in the non gatekeeping system and,

$$U_g^{3\prime} = \left(\frac{1}{2}\right)(p_g\,(m+2)) - k\frac{(e^{3\prime})^2}{2} - r\frac{1-e^{3\prime}}{4}$$

in the gatekeeping system.

Proof The optimal effort carries out by GPs is given by

$$\begin{array}{c} Max\ U_g^{3\prime} \\ e \\ \begin{cases} e \geq \varepsilon' \\ e \leq 1 \end{cases} \end{array}$$

in a non gatekeeping system and,

$$\begin{array}{c} Max\ U_g^{3\prime\prime} \\ e \\ \begin{cases} e \geq \varepsilon' \\ e \leq 1 \end{cases} \end{array}$$

in a gatekeeping system.

Using these lemmas we compute in the following section the incentives constraints.

4.3 Incentives constraints

In this presentation we focus on the second best contracts under which GPs have a financial incentive to implement the adequate treatment strategy[5].

Lemma 6 *The primary health care provider decides to treat his patient when a mild illness is diagnosed instead of implementing a blind treatment strategy if:*

$$e^{3\prime}(r - 2ke^{3\prime}) \geq \mid r - 2p_g m \mid$$

with $e^{3\prime} = min\{\frac{r}{4k}, 1\}$.
The primary health care provider performs a level of diagnosis effort $e^{3\prime} = min\{\frac{r}{4k}, 1\}$.
His expected utility is:

$$U_g^{3\prime} = \left(\frac{p}{2}\right)(p_g\,(m+2)) - pk\frac{(e^{3\prime})^2}{2} - r\frac{p(1-e^{3\prime})}{4}$$

in a non gatekeeping system and,

$$U_g^{3\prime\prime} = \left(\frac{1}{2}\right)(p_g\,(m+2)) - k\frac{(\hat{e}^3)^2}{2} - r\frac{(1-e^{3\prime\prime\prime})}{4}$$

and in a gatekeeping system,

In the following section, we compute the optimal payment schemes in the gatekeeping and non gatekeeping systems.

[5] For some values of the parameters which are not given here it may be socially optimal to give financial incentives to GPs to carry out blind strategies.

4.4 Payment schemes

In this section we compute for both health care organisations the incentive payment scheme under which GPs carry out the most adequate treatment. Since there is no asymmetric information between specialists and the health care insurer specialists' FFS are the same as in the case with perfect information.

In both cases we suppose that $k \leq \frac{r}{4}$.

4.4.1 In the non gatekeeping system

In this case the health insurer must solve:

$$\underset{p_g, p_s}{Max\ U_r^{3\prime}}$$

$$\begin{cases} U_g^{3\prime} \geq \omega_g \\ U_s^{3\prime} \geq \omega_s \\ e^{3\prime}(r - 2ke^{3\prime}) \geq \mid r - 2p_g m \mid \\ p_g \geq 0 \\ p_s \geq 0 \\ e^{3\prime} = min\{\frac{r}{4k}, 1\} \end{cases}$$

Proposition 1 *The FFS of the second best contract are:*

- if $\frac{m}{p}\omega_g \leq k \leq \frac{r}{4}$,

$$p_g^{3\prime} = \frac{k}{m}$$

for GPs and

$$p_s^{3\prime} = \frac{2\omega_s}{(s+1) + (m+1)(1-p)}$$

for specialists.

Under this contract the utility of the health care insurer is:

$$\begin{aligned} U_r^{3\prime} &= U_1\left(1 - \frac{p}{2}\right) + U_2\left(\frac{p}{2}\right) - \frac{pk}{2} \\ &- \frac{\lambda pk\,(m+2)}{2m} \\ - &\quad \lambda\omega_s \\ - &\quad (1+\lambda)\left(\left(\frac{1-p}{2}\right)c_1 + \left(\frac{1-p}{2} + \frac{p}{2}\right)c_2\right) \end{aligned}$$

- if $k \leq \min\{\frac{m}{p}\omega_g, \frac{r}{4}\}$,

$$p_g^{3\prime} = \frac{2}{p\,(m+2)}\left(\omega_g + \frac{pk}{2}\right)$$

for GPs and

$$p_s^{3\prime} = \frac{2\omega_s}{(s+1) + (m+1)(1-p)}$$

for specialists.

Under the utility of the health care insurer is:

$$U_r^{3\prime} = U_1\left(1-\frac{p}{2}\right) + U_2\left(\frac{p}{2}\right)$$
$$-(1+\lambda)\left(pk\frac{1}{2} + \left(\frac{1-p}{2}\right)c_1 + \left(\frac{1}{2}\right)c_2\right)$$
$$-\lambda\left(\omega_g+\omega_s\right)$$

Proof In this case the incentive constraint is:

$$\mid r - 2p_g m \mid \leq e^{3\prime}(r - 2ke^{3\prime})$$

with

$$e^{3\prime} = min\{\frac{r}{4k}, 1\}$$

The participation constraint of GPs is:

$$p_g \geq \frac{2}{p\,(m+2)}\left(\omega_g + pk\frac{(e^{3\prime})^2}{2} + r\frac{p(1-e^{3\prime})}{4}\right)$$

The participation constraint of specialists implies:

$$p_s^3 = \frac{2\omega_s}{(s+1)+(m+1)\left(1-p+\frac{p(1-e_s^3)}{2}\right)}$$

Since we have assumed that $k \leq \frac{r}{4}$ the optimal level of effort is:

$$e^{3\prime} = 1$$

In this case the FFS of specialists is:

$$p_s^{3\prime} = \frac{2\omega_s}{(s+1)+(m+1)\,(1-p)}$$

The incentive constraint of GPs becomes:

$$\mid r - 2p_g m \mid \leq r - 2k$$

$\Longleftrightarrow$

$$k \leq p_g m \leq r - k$$

These last inequalities are always satisfied since $k \leq \frac{r}{4}$.
Taking into account GPs' participation constraint we conclude that there are two cases:

- if $\frac{k}{m} \geq \frac{2}{p(m+2)}\left(\omega_g + \frac{pk}{2}\right) \Longleftrightarrow k \geq \frac{m}{p}\omega_g$

Then under

$$p_g^{3\prime} = \frac{k}{m}$$

GPs have a financial incentive to implement the most adequate treatment.
Under these conditions, their utility is:

$$U_g^{3\prime} = \left(\frac{p}{2}\right)\left(\frac{k}{m}\,(m+2)\right) - \frac{pk}{2}$$

The utility of the insurer is:

$$U_r^{3\prime} = U_1\left(1-\frac{p}{2}\right) + U_2\left(\frac{p}{2}\right) - \frac{pk}{2}$$
$$-\frac{\lambda pk\,(m+2)}{2m}$$
$$-\quad \lambda\omega_s$$
$$-\quad (1+\lambda)\left(\left(\frac{1-p}{2}\right)c_1 + \left(\frac{1-p}{2}+\frac{p}{2}\right)c_2\right)$$

- *if* $\frac{k}{m} \leq \frac{2}{p(m+2)}\left(\omega_g + \frac{pk}{2}\right) \Longleftrightarrow k \leq \frac{m}{p}\omega_g$,

Then GPs have a financial incentive to implement the most adequate treatment only under

$$p_g^{3\prime} = \frac{2}{p\,(m+2)}\left(\omega_g + \frac{pk}{2}\right)$$

Under these conditions, their utility is:

$$U_g^{3\prime} = \omega_g$$

The utility of the insurer is:

$$U_r^{3\prime} = U_1\left(1-\frac{p}{2}\right) + U_2\left(\frac{p}{2}\right)$$
$$-(1+\lambda)\left(pk\frac{1}{2} + \left(\frac{1-p}{2}\right)c_1 + \left(\frac{1}{2}\right)c_2\right)$$
$$-\lambda\left(\omega_g+\omega_s\right)$$

■

In the following section we compute the optimal payment schemes in a gatekeeping system.

4.4.2 In the gatekeeping system

In this case the health insurer must solve:

$$\underset{p_g,p_s}{Max}\; U_r^{3\prime\prime}$$
$$\begin{cases} U_g^{3\prime\prime} \geq \omega_g \\ U_s^{3\prime\prime} \geq \omega_s \\ e^{3\prime\prime}(r-2ke^{3\prime\prime}) \geq \mid r - 2p_g m \mid \\ p_g \geq 0 \\ p_s \geq 0 \\ e^{3\prime\prime} = min\{\frac{r}{4k}, 1\} \end{cases}$$

Proposition 2 *The FFS of the second best contract are:*

- *if* $m\omega_g \leq k \leq \frac{r}{4}$,

$$p_g^{3\prime\prime} = \frac{k}{m}$$

for GPs and

$$p_s^{3\prime\prime} = \frac{2\omega_s}{(s+1)}$$

for specialists.
Under the utility of the health care insurer is:

$$\begin{aligned} U_r^{3''} &= \frac{1}{2}\left(U_1+U_2\right)-\frac{k}{2} \\ &-\frac{\lambda k\left(m+2\right)}{2m} \\ - & \lambda\omega_s \\ - & \frac{(1+\lambda)}{2}c_2 \end{aligned}$$

- *if* $k \leq \min\{m\omega_g, \frac{r}{4}\}$,

$$p_g^{3''} = \frac{2}{(m+2)}\left(\omega_g + \frac{k}{2}\right)$$

for GPs and

$$p_s^{3''} = \frac{2\omega_s}{(s+1)}$$

for specialists.
Under the utility of the health care insurer is:

$$\begin{aligned} U_r^{3''} &= \frac{1}{2}\left(U_1+U_2\right) \\ &-\frac{(1+\lambda)}{2}\left(k+c_2\right) \\ &-\lambda\left(\omega_g+\omega_s\right) \end{aligned}$$

■

Proof In this case the incentive constraint is:

$$\mid r - 2p_g m \mid \leq e^{3''}(r - 2ke^{3''})$$

with

$$e^{3''} = min\{\frac{r}{4k}, 1\}$$

The participation constraint of GPs is:

$$p_g \geq \frac{2}{(m+2)}\left(\omega_g + k\frac{(e^{3'})^2}{2} + r\frac{(1-e^{3'})}{4}\right)$$

The participation constraint of specialists implies:

$$p_s^{3''} = \frac{2\omega_s}{(s+1)+(m+1)\left(\frac{(1-e_s^{3''})}{2}\right)}$$

Since we have assumed that $k \leq \frac{r}{4}$ the optimal level of effort is:

$$e^{3''} = 1$$

In this case the FFS of specialists is:

$$p_s^{3''} = \frac{2\omega_s}{(s+1)}$$

and the participation constraint of GPs is:

$$p_g \geq \frac{2}{(m+2)}\left(\omega_g + \frac{k}{2}\right)$$

The incentive constraint of GPs becomes:

$$\mid r - 2p_g m \mid \leq r - 2k$$

$\Longleftrightarrow$

$$k \leq p_g m \leq r - k$$

These last inequalities are always satisfied since $k \leq \frac{r}{4}$.
Taking into account GPs' participation constraint we conclude that there are two cases:

- if $\frac{k}{m} \geq \frac{2}{(m+2)}\left(\omega_g + \frac{k}{2}\right) \Longleftrightarrow k \geq m\omega_g$

Then under

$$p_g^{3\prime\prime} = \frac{k}{m}$$

GPs have a financial incentive to implement the most adequate treatment.
Under these conditions, their utility is:

$$U_g^{3\prime\prime} = \left(\frac{1}{2}\right)\left(\frac{k}{m}(m+2)\right) - \frac{k}{2}$$

The utility of the insurer is:

$$\begin{aligned} U_r^{3\prime\prime} &= U_1\left(\frac{1}{2}\right) + U_2\left(\frac{1}{2}\right) - \frac{k}{2} \\ & -\frac{\lambda k(m+2)}{2m} \\ - & \quad \lambda\omega_s \\ - & \quad \frac{(1+\lambda)}{2}c_2 \end{aligned}$$

- if $\frac{k}{m} \leq \frac{2}{(m+2)}\left(\omega_g + \frac{k}{2}\right) \Longleftrightarrow k \leq m\omega_g$

Then GPs have a financial incentive to implement the most adequate treatment only under:

$$p_g^{3\prime\prime} = \frac{2}{(m+2)}\left(\omega_g + \frac{k}{2}\right)$$

The utility of the insurer is:

$$\begin{aligned} U_r^{3\prime\prime} &= U_1\left(\frac{1}{2}\right) + U_2\left(\frac{p}{2}\right) \\ & -(1+\lambda)\left(k\frac{1}{2} + + \left(\frac{1}{2}\right)c_2\right) \\ & -\lambda(\omega_g + \omega_s) \end{aligned}$$

■

Since we have computed the optimal payment schemes for both health care organisations we can compare them.

5 Comparison

In this section we study the impact of restricting access to specialty care on:
- GPs' FFS,
- specialists' FFS,
- the insurer's utility.

Proposition 3 *Shifting from non gatekeeping to gatekeeping system increases the FFS of specialists.*

Proof The sign of the difference of FFS is:

$$p_s^{3\prime\prime} - p_s^{3\prime} = \frac{2\omega_s (m+1)(1-p)}{(s+1) + (m+1)(1-p)} > 0$$

■

This result is rather intuitive: since in a gatekeeping system fewer patients consult their specialists, the insurer must increase their FFS to satisfy their participation constraint.

Proposition 4 *According to the disutility of effort shifting from non gatekeeping to gatekeeping systems have no effect or decrease the GPs' FFS.*

Proof In the case of a small disutility of effort the sign of the difference of the FFS is:

$$p_g^{3\prime\prime} - p_g^{3\prime} = \frac{2}{(m+2)} \omega_g \left(1 - \frac{1}{p}\right) < 0$$

In the other case we see that:

$$p_g^{3\prime} = p_g^{3\prime\prime} = \frac{k}{m}$$

■

This result is intuitive, particularly with a low disutility of effort. In such a case, since it is not costly for a GP to implement the most adequate treatment and since more patients consult him, the insurer can decrease the FFS of the GP which satisfies his participation constraint.

With a high disutility of effort, the FFS is the same in the gatekeeping and non gatekeeping system, due to two conflicting effects:
- on the one hand, more patients consult him, which should a priori decrease the level of the FFS,
- on the other hand, since the disutility of effort is high, the insurer must increase the FFS of the GP to give a financial incentive to perform the most adequate treatment.

We can conclude that the gatekeeping system is not necessarily cheaper than the non gatekeeping, because shifting from non gatekeeping to gatekeeping systems:
- increases the FFS of specialists,
- decreases or does not change the FFS of GPs.

Proposition 5 *The insurer prefers implementing a non gatekeeping system instead of a gatekeeping system depending on the costs and the utilities of treatments.*

Proof In the case of a small disutility of effort the sign of the difference of insurer's utilities is given by the following equation:

$$U_r^{3\prime} - U_r^{3\prime\prime} = \left(\frac{1-p}{2}\right) \left[(U_1 - U_2) - (1+\lambda)(c_1 - k)\right]$$

We can conclude that the gatekeeping system is socially optimal if:

$$c_1 > \frac{(U_1 - U_2)}{(1+\lambda)} + k$$

In the case of a large disutility of effort the sign of the difference of the insurer's utility is given by the following equation:

$$U_r^{3\prime} - U_r^{3\prime\prime} = \left(\frac{1-p}{2}\right)\left((U_1 - U_2) + k + \frac{\lambda k\,(m+2)}{m} - (1+\lambda)c_1\right)$$

We can conclude that the gatekeeping system is socially optimal if:

$$c_1 \geq \frac{1}{(1+\lambda)}\,(U_1 - U_2) + k + \frac{\lambda k\,(m+2)}{m}$$

■

If we compare gatekeeping and non gatekeeping system taking into account:

- their cost and,
- their benefit

we conclude that a gatekeeping system is socially optimal only if the cost of treatment of a minor illness by specialists is too high.

6 Conclusion

In this paper, we compared gatekeeping and non gatekeeping systems under imperfect information. We assume that in both organisations physicians are paid under FFS.

Our results are the following ones:

- shifting from a non gatekeeping to gatekeeping systems increases the FFS of specialists, since fewer patients consult them,
- shifting from a non gatekeeping to gatekeeping systems decreases the FFS of GPs only if the disutility of effort is low, since more patients consult them. But if the disutility of effort is high the FFS in a gatekeeping system is identical to the FFS in a non gatekeeping system, even if more patients consult them.

We can conclude that a gatekeeping system is not cheaper than a non gatekeeping system even if it avoids useless treatment. Moreover a non gatekeeping may still be socially optimal if we trade off between:

- the costs of treatment,
- the utility of a faster recovery due to the free access to specialty care.

Our future research follows one main direction. We are setting up another model to study the PPOs. In the model presented here we assume that patients must go to their GPs first. But in some PPOs insurers have implemented co-payments which allow patients to get to specialty care according to their symptoms. In this new model we first compute the optimal health care payment when the insurer perfectly observes patients' symptoms and GPs' decisions, i.e. the level of effort and the treatment carried out. Then we assume that the insurer observes neither GPs' decisions nor the symptoms of the patients. It means that the health care insurer is in a situation with double moral hazard and adverse selection. In this case the health insurer first computes optimal co-payments under which patients consult primary health care providers if they have mild symptoms and consult secondary health care providers otherwise. Then he computes the optimal payments schemes under which GPs treat their patients when they diagnose the mild disease and to refer them otherwise. We finally compare this health care organisation to the genuine gatekeeping and non-gatekeeping systems.

Bibliography

Bardey D. (2002) - Demande induite et réglementation de médecins altruistes, *Revue économique*, 53, pages 581-588.

Jelovac I. (2001) - Physicians' payment contracts, treatment decisions and diagnosis accuracy, *Health Economics*, 10, pages 9-25.

Levaggi R. and Rochaix L. (2007) - Exit, Choice or Loyalty: Patient Driven Competition in Primary Care, *Annals of Public and Cooperative Economics*, 78, pages 501-535.

Marinoso B.G. and Jelovac I. (2003) - GPs'payments contracts and their referral practice, *Journal of Health Economics*, 22, pages 617-635.