Optimal Prevention and Savings: How to Deal with Fatalism?

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Abstract

In this paper, we study the relationship between prevention and savings and analyze their socially optimal levels. In a first part, we analyze optimal decisions of primary prevention and savings when individuals face a health risk involving expenses that can not be covered by any insurance (private or public). We take into account the possibility for the individuals to underestimate or overestimate the health risk. To manage health risk, individuals have two possibilities: invest in primary prevention, in order to reduce the probability of the disease and/or save, in order to face the costs of the disease that are not covered by insurance. We show that the impact of wealth and interest rate on prevention and savings decisions strongly depends on the perceived substituability between health and wealth. In the second part of the paper, as prevention generates externalities, individuals' optimal levels of prevention are lower than the socially optimal ones. In this context, we analyze social optimum and its decentralization by tax-financed government subsidies to prevention expenses.

Keywords: health risk, primary prevention, overlapping generation model.
JEL *Classification* : D91, I12, I18.

1 Introduction

Prevention and incentives to increase it have become an important challenge for Health Authorities in most of the developed countries.

According to an estimate by the centres for Disease Control and Prevention, total spending on prevention in the US in the nineties (around 0.8% of GNP)is significantly lower than the levels recommended by major professional organizations such as the US Preventive Services Task Force and the American Cancer Society (Brown et alii [1991]). In France, prevention expenses are evaluated at 7% from total medical expenses in 1998, level considered also as incompletely satisfactory by the authorities (French Economic and Social Council). Consequently, the French Codex of social security has been modified in 2002 in order to give more importance to prevention in public health policy.

What determines the efficiency of expenditures in prevention? Disease eradication, due to its very high cost, is not always a reasonable public policy goal. Moreover, interaction between the prevalence of disease and the demand for prevention (such as vaccines) can create forces that make the eradication of the disease difficult (Geoffard and Philipson [1997]). There will be enough prevention when individual decisions and private markets lead to socially optimal outcomes. Thus, understanding the individually optimal prevention decisions is a preliminary for the determination of socially optimal prevention levels.

For an individual, one way to respond to a health risk is to engage in self-protection (see Kenkel [2001]). The theoretical literature on prevention developed essentially in two main directions. The first one uses human capital models and prevention is considered as a special type of investment in human capital (see Grossman [1972], Ehrlich, Chuma [1990] etc.). The second one focuses essentially on individual decisions concerning prevention and on the trade-off between insurance and prevention (see for instance Elhrich, Becker [1972] for general prevention choices and Zweifel and Breyer [1997] for studies in health context).

These last studies prove that secondary prevention is a substitute for insurance as it leads to the same type of risk reduction as insurance does. Thus, the analysis of decisions concerning it is similar to that of insurance demand.

The impact of primary prevention on risk exposure is more complex and has to be considered in a long term setting. In an intertemporal approach, health risk generating wealth risk, individuals can prevent themselves against it by making precautionary savings. Consequently, primary prevention decision can interact with savings decision. The concept of Medical Savings Accounts, existing in the United States, can illustrate the importance of savings for health risk coverage (see Courbage (1996) and Moon et al. (1996)).

In this paper, to enlighten the trade-off between prevention and savings, we ignore the insurance choices (trade-offs between insurance and prevention have been studied first in health context by Phelps [1978], trade-offs between insurance and savings have been studied by Dionne and Eeckhoudt [1984]). We analyze optimal decisions of primary prevention and savings, and their consequences on macroeconomic equilibrium, when individuals face a health risk involving expenses that cannot be covered by any insurance (private or public).

Indeed, in most of the developed countries, there exists a public and compulsory health insurance. However, a part of medical expenses are not covered by the public system. Thus, the expenses for an individual resulting from a disease involve on one hand a minimal treatment costs covered by social insurance and on the other hand additional costs (higher quality treatment, home care etc.) paid by the individual himself.

We consider a two-period overlapping generation model. Individuals, whose utility functions depend both on consumption and health, face a health risk which probability of occurrence is perfectly known. We suppose that only a fixed part of the treatment costs are covered by a compulsory public insurance. To manage the residual health risk, individuals have two possibilities: invest in primary prevention, which reduces the probability of the disease and/or save, in order to face the costs of the disease that are not covered by public insurance. To take into account individuals risk perceptions, we use the Rank Dependent Utility model (Quiggin [1982], Yaari [1987]) that involves, in addition to standard utility function, a probability transformation function that can reflect pessimism or optimism.

We show that the impact of wealth and co-payment rate on optimal individual preventions and savings strongly depend on the substitutability (or complementarity) between the two health risk management tools. Concerning the impact of risk perception on optimal prevention, two types of agents have to be distinguished: the moderate pessimists and the fatalists. The moderate pessimists overestimate the probability of disease and can overreact by choosing a relatively high level of prevention. Fatalists, who are also pessimists, do not believe in the efficiency of prevention and thus invest less in it.

The understanding of individual behaviors allows a better analyzis of the role of risk perception at equilibrium. In this paper, externalities generated by prevention are double. First, an investment in prevention leads to a reduction, ex post, of the proportion of the population who becomes sick and thus leads to a reduction of total expected costs of treatment that have to be covered by social insurance. Second, we suppose that the marginal cost of treatment depends on the number of patients. For some pathologies, the cost admits some decreasing returns to scale (scanner, Magnetic Resonance Imaging (MRI)); for others, it can be an increasing function (for example, in case of epidemics, some congestion can appear in hospitals).

The competitive equilibrium levels of prevention, according to the intuition, are lower than the socially optimal ones. This gives room for public intervention in order to restore optimality. The instrument that we introduce consists in subsidizing prevention and financing these subsidies by an increase in taxes.

The paper is organized as follows. In section 2, we study interactions between the two decisions (savings and prevention) and the impact of different parameters as wealth and co-payment rate on these decisions. This section ends with the study of the impact of risk perception on decisions. Section 3 is devoted to the determination of the long term competitive equilibrium. In section 4, we determine the social optimum and we propose to decentralize it by introducing a system of subsidies. Section 5 contains a brief conclusion.

2 Tradeoff between Savings and Prevention

In this section, we study the individual decisions of prevention and savings. We assume that in the economy health expenditures are only partially covered by a compulsory social insurance. To limit moral hazard, a part of costs are paid by patients[1]. To simplify the analysis and focus on the prevention-saving trade-offs, we assume that these co-payment rate is fixed and uniform. A detailed discussion on the optimal and differential co-payment rates is done in Eeckhoudt and alii [2004].

[1] Note that a recent reform in France introduced a fixed fee of 1 euro for any medical act, suppressing by this way any possibilities for total reimbursement of medical treatment.

2.1 Individual Optimal Choice

Individuals live for two periods and derive utility from consumption and the quality of health status in their two periods of life.

Agents face a health risk. For simplicity, we suppose that there are only two states of health at each period. With probability p_t, an individual born in t falls in at the second period of life, $H_{t+1} = \underline{H}$, and he/she has to pay a part of the cost of the treatment, m. With probability $(1 - p_t)$, the individual remains in good health, $H_{t+1} = \overline{H}$. Consequently, the risk on health status implies a risk on the future revenue.

Agents' preferences are supposed separable in time. Moreover, their preferences toward risk are represented in the framework of RDU model by $U(c_t, H_t) + \delta E_{\varphi} U\left(\widetilde{d}_{t+1}, \widetilde{H}_{t+1}\right)$ where c_t and $\widetilde{d}_{t+1}$ are respectively consumptions at period t and $t+1$, δ the discount factor and function $E_{\varphi} U\left(\widetilde{d}, \widetilde{H}\right)$ writes:

$$\begin{aligned} E_{\varphi} U\left(\widetilde{d}, \widetilde{H}\right) &= U\left(\underline{d}, \underline{H}\right) + \varphi(1-p)\left[U\left(\overline{d}, \overline{H}\right) - U\left(\underline{d}, \underline{H}\right)\right] \\ &= \left[1 - \varphi(1-p)\right] U\left(\underline{d}, \underline{H}\right) + \varphi(1-p)\, U\left(\overline{d}, \overline{H}\right) \end{aligned}$$

with φ an increasing and differentiable function : $[0,1] \rightarrow [0,1]$, which transforms the probability distribution.

The function $U(.,.)$ is assumed to be twice continuously differentiable, strictly increasing and strictly concave with respect to its two arguments:

Assumption A1.
For all $c > 0$, and all H, one has $U'_c(c, H) > 0, U'_H(c, H) > 0, U''_{cc}(c, H) < 0$, $U''_{HH}(c, h) < 0$, $\lim_{c \to 0} U'_c(c, H) = +\infty$.

The attitude toward risk is characterized by properties of functions U and φ. An individual will be called pessimist if $\varphi(q) < q, \forall q \in [0,1]$ and optimist in the opposite case.The relation between the properties of the probability transformation function and risk aversion is well enlightened in our case of two states of nature. Indeed, as $\left(\widetilde{d}, \widetilde{H}\right)$ takes only two values $\left(\underline{d}, \underline{H}\right)$ and $\left(\overline{d}, \overline{H}\right)$, with $\underline{d} < \overline{d}$ and $\underline{H} < \overline{H}$, it appears that a pessimistic (optimistic) agent will underestimate (overestimate) the probability of the good state of nature: $\varphi(1-p) \leq (\geq) 1-p$ and overestimate (underestimate) the probability of the bad state of nature: $1-\varphi(1-p) \leq (\geq)p$. Let us notice also that pessimism increases when $\varphi(1-p)$ decreases.

For linear or concave utility functions, pessimism is equivalent to weak risk aversion. Strong risk aversion is characterized by a convex probability transformation function[2]. Here we assume that agents are strongly risk averse ($\varphi'' < 0$).

At the first period t, agents supply one unit of labour inelastically, earn the competitive market wage, w_t, pay taxes τ_t and consume c_t. He/she has the possibility to invest a part of his/her net income in primary prevention, h_t, and in savings, s_t, with return, $R_{t+1} = 1 + r_{t+1}$, where r_{t+1} is the interest rate at period $t+1$. Primary prevention reduces the probability of the disease according to the following prevention technology: an expense of h_t in prevention leads to a probability of illness of $p(h_t)$ with $p' < 0$ and $p'' \geq 0$, $p(0) = p$.

Let us denote by m the part of the treatment cost paid by the patient. When agents are old they consume all their net wealth that is savings return, $R_{t+1}s_t$, minus the potential part of cost of the treatment, $\widetilde{m}$, where $\widetilde{m}$ takes two values: m with probability p and 0 with probability $1-p$. Then $\widetilde{d}_{t+1} = d_{t+1} - \widetilde{m}$ with $d_{t+1} = R_{t+1}s_t$.

The agents prevention and saving levels are solutions of the following program:

$$\begin{aligned}
\max_{c_t d_{t+1}, s_t, h_t} \; & U(c_t, H_t) + \delta (1 - \varphi(1 - p(h_t))) U(d_{t+1} - m, \underline{H}) \\
& + \delta \varphi (1 - p(h_t)) U\left(d_{t+1}, \overline{H}\right) \qquad (1) \\
& s.\ t.\ w_t - \tau_t = c_t + s_t + h_t \\
& d_{t+1} = R_{t+1}s_t \qquad (2) \\
& c_t \geq 0, \quad d_{t+1} \geq m
\end{aligned}$$

We can rewrite this program:

$$\begin{aligned}
& \max_{s_t, h_t} U(w_t - \tau_t - s_t - h_t, H_t) + \qquad (3) \\
& \delta \left[(1 - \varphi(1 - p(h_t))) U(R_{t+1}s_t - m, \underline{H}) + \varphi(1 - p(h_t)) U\left(R_{t+1}s_t, \overline{H}\right) \right]
\end{aligned}$$

[2] Characterizations of risk aversion in RDU model are due to Yaari (1987), Roell (1987), Chew-Karni-Safra (1987), Quiggin (1991) and Chateauneuf-Cohen (1994).

We suppose that the second order conditions are verified.

More precisely, for all $c > 0$, and all H, one has $V_{cc} \equiv U''_{cc} + \delta R^2_{t+1} E U''_{dd} < 0$
Assumption A2.
$V_{hh} \equiv U''_{cc} + \delta \left[\varphi' \left(1 - p\left(h_t\right)\right) p''\left(h_t\right) - \varphi''\left(1 - p\left(h_t\right)\right)\left(p'\left(h_t\right)\right)^2\right] \times$
$\left[U\left(d_{t+1} - m, \underline{H}\right) - U\left(d_{t+1}, \overline{H}\right)\right] < 0$
$V_{ss} V_{hh} - \left(V_{sh}\right)^2 > 0$ with
$V_{sh} \equiv U''_{cc} + \delta R_{t+1} p'\left(h_t\right) \varphi'\left(1 - p\left(h_t\right)\right)\left[U'_d\left(d_{t+1} - m, \underline{H}\right) - U'_d\left(d_{t+1}, \overline{H}\right)\right].$

Let us remark that expression V_{sh} can be positive, negative or nil. Its sign depends on the sign of the cross second derivative $U''_{cH}(c, H)$ which can be positive or negative. A common assumption in the literature is that $U''_{cH}(c, H) \geq 0$. As it has been showed by Viscusi and Evans [1990] and Sloan et al. [1998], this assumption is reasonable in the case of severe injuries. For minor one, Evans and Viscusi [1991] find that $U''_{cH}(c, H)$ could be negative.

At each period t, the optimal conditions are

$$V_{s_t} \equiv -U'_c\left(c_t, H_t\right) + \delta R_{t+1}\left[\left(1 - \varphi\left(1 - p\left(h_t\right)\right)\right) U'_d\left(R_{t+1} s_t - m, \underline{H}\right) + \varphi\left(1 - p\left(h_t\right)\right) U'_d\left(R_{t+1} s_t, \overline{H}\right)\right] = 0 \quad (4)$$

$$V_{h_t} \equiv -U'_c\left(c_t, H_t\right) + \delta \varphi'\left(1 - p\left(h_t\right)\right) p'\left(h_t\right)\left[U\left(R_{t+1} s_t - m, \underline{H}\right) - U\left(R_{t+1} s_t, \overline{H}\right)\right] = \begin{cases} 0 \text{ if } h_t > 0 \\ \leq 0 \text{ if } h_t = 0 \end{cases} \quad (5)$$

with $d_0 = R_0 s_{-1}$ given.

(i) The first condition (4) is the trade-off condition between consumptions over life cycle.

For a given level of prevention, we obtain that the savings level has the usual properties: it is an increasing function of first period income, w_t, increasing function of m, and the effect of an increase in interest rate is indeterminate.

Consider now the effect of an exogenous increase of the level of prevention on savings:

$$\frac{\partial s_t}{\partial h_t} = -\frac{V_{sh}}{V_{ss}} = -\frac{U''_{cc} + \delta R_{t+1} \varphi'\left(1 - p\left(h_t\right)\right) p'\left(h_t\right)\left[U'_d\left(d_{t+1} - m, \underline{H}\right) - U'_d\left(d_{t+1}, \overline{H}\right)\right]}{U''_{cc} + \delta R^2_{t+1} E_{\varphi} U''_{dd}} \quad (6)$$

If $U''_{cH}(c,H) \leq 0$, the sign of $\frac{\partial s_t}{\partial h_t}$ is negative which means that savings and prevention are substitute goods.

If $U''_{cH}(c,H) > 0$, the sign of $\frac{\partial s_t}{\partial h_t}$ is ambiguous and we can obtain that it is positive if $U'_d(d_{t+1} - m, \underline{H}) < U'_d\left(d_{t+1}, \overline{H}\right)$ and if the prevention is perceived as sufficiently efficient $(-p'(h_t)\varphi'(1-p(h_t))$ high).

Consequently, the relationship between savings and prevention does not have to be negative throughout.

(ii) Regarding the second condition (5), we obtain that the level of prevention is strictly positive when

$$-U'_c(w_t - \tau_t - s_t, H_t) + \delta\varphi'(1-p(0))\,p'(0)\left[U(d_{t+1} - m, \underline{H}) - U\left(d_{t+1}, \overline{H}\right)\right] > 0$$

for a given s_t.

This condition is always verified under the assumption $\lim_{h\to 0} p'(h) = -\infty$ which means that an increase in primary prevention is infinitely efficient around zero.

Let us consider the case where $h_t > 0$, (5) rewrites

$$U'_c(c_t, H_t) = \delta\varphi'(1-p(h_t))\,p'(h_t)\left[U(d_{t+1} - m, \underline{H}) - U\left(d_{t+1}, \overline{H}\right)\right] \quad (7)$$

The right-hand side of equation (7) represents the increase in utility due to a reduction in the probability perceived of illness due to an increase of one unit h_t. The left-hand side shows the loss of utility due to the reduction of the disposable income for savings and consuming.

For a given level of savings, we obtain that the level of prevention increases with the income and with the level of the treatment cost supported by the individual, m.

2.2 Effects of income and co-payment rate on savings and prevention

The consumer chooses the level of savings, $s_t = \widehat{s}(w_t, \tau_t, R_{t+1}, m)$ and prevention, $h_t = \widehat{h}(w_t, \tau_t, R_{t+1}, m)$ which are solution of both equations (4) and (5). The impact of an increase in first-period income and in the co-payment rate on optimal savings and prevention strongly depend on the complementarity or substituability of the two risk management tools.

To determine the impact of different parameters on savings and prevention, we use the following general formulas resulting from a total differentiation of the optimality conditions (4) and (5).

Thus, to calculate the impact of any parameter α on the optimal levels of savings and prevention, we use the following relations:

$$\begin{pmatrix} V_{ss} & V_{sh} \\ V_{hs} & V_{hh} \end{pmatrix} \begin{pmatrix} ds_t \\ dh_t \end{pmatrix} = - \begin{pmatrix} V_{s\alpha} \\ V_{h\alpha} \end{pmatrix} d\alpha$$

that imply:

$$\frac{ds_t}{d\alpha} = \frac{\begin{vmatrix} -V_{s\alpha} & V_{sh} \\ -V_{h\alpha} & V_{hh} \end{vmatrix}}{\Delta} \text{ and } \frac{dh_t}{d\alpha} = \frac{\begin{vmatrix} V_{ss} & -V_{s\alpha} \\ V_{hs} & -V_{h\alpha} \end{vmatrix}}{\Delta} \tag{8}$$

with $\Delta = V_{ss}V_{hh} - (V_{sh})^2 > 0$.

The following proposition resumes the comparative statics results.

Proposition 1 *(i) Effect of an increase in wage, w_t*

- If savings and prevention are complementary, then $\frac{ds_t}{dw_t} > 0$ and $\frac{dh_t}{dw_t} > 0$;
- If savings and prevention are substitutes, then $sign\left(\frac{ds_t}{dw_t}\right)$ and $sign\left(\frac{dh_t}{dw_t}\right)$ are ambiguous but $\frac{ds_t}{dw_t} + \frac{dh_t}{dw_t} > 0$.

(ii) Effect of an increase in the co-payment rate m.

- If savings and prevention are complementary, then $\frac{ds_t}{dm} > 0$ and $\frac{dh_t}{dm} > 0$;
- If savings and prevention are substitutes, then $sign\left(\frac{ds_t}{dm}\right)$ and $sign\left(\frac{dh_t}{dm}\right)$ are ambiguous.

Proof. $V_{sw_t} = -U''_{cc} > 0$
$V_{hw_t} = -U''_{cc} > 0$
From (8),

$$sign\left(\frac{ds_t}{dw_t}\right) = -sign\left(V_{hh}V_{sw_t} - V_{sh}V_{hw_t}\right)$$

and

$$sign\left(\frac{dh_t}{dw_t}\right) = -sign\left(V_{ss}V_{hw_t} - V_{sh}V_{sw_t}\right)$$

The results follow directly for $V_{sh} \geq 0$ due to $V_{hh} < 0$ and $V_{ss} < 0$.

For $V_{sh} < 0$, we use the following transformation of (8) with $A = V_{hw_t} = V_{sw_t} > 0$:

$$\frac{ds_t}{dw_t} + \frac{dh_t}{dw_t} = -\frac{A}{V_{ss}} + \frac{A}{V_{ss}}\frac{(V_{ss} - V_{sh})^2}{(V_{sh}^2 - V_{ss}V_{sh})} > 0$$

$V_{sm} = -\delta RU''_{dd}\left(d_{t+1} - m, \underline{H}\right) > 0$
$V_{hm} = -\delta p'\left(h_t\right)\varphi'\left(1 - p\left(h_t\right)\right)U'_d\left(d_{t+1} - m, \underline{H}\right) > 0$
From (8),

$$sign\left(\frac{ds_t}{dm}\right) = sign\left(V_{sh}V_{hm} - V_{sm}V_{hh}\right)$$

and

$$sign\left(\frac{dh_t}{dm}\right) = sign\left(V_{sh}V_{sm} - V_{ss}V_{hm}\right)$$

The results follow directly for $V_{sh} \geq 0$ due to $V_{hh} < 0$ and $V_{ss} < 0$.

For $V_{sh} < 0$, the same transformations as in the previous proposition are needed. ■

The previous results can be interpreted in the following way.

(i) Effects of an increase in wage.

When the first-period income increases, first-period and second-period consumptions increase, thus $(s_t + h_t)$ increases but there are two effects on each decision variable.

A positive direct effect. When wage increases, as savings and health prevention are normal goods, the individual is incited to increase each variable.

A positive or negative cross effect.

When savings and prevention are complementary, an increase in one decision variable is accompanied with an increase in the other. This second effect reinforces the first one.

When savings and prevention are substitutes, an increase in one decision variable goes with a decrease in the other. This effect is opposite to the first one and consequently, the global effect is ambiguous.

(ii) Effects of an increase in co-payment rate.

Our results imply that an increase in the co-payment rates is not always a good tool for increasing prevention. Its impact results from the respective magnitude of two effects.

A positive direct effect. When the reimbursement decreases (that is m increases), as savings and health prevention are normal goods, the individuals tend to increase the two variables.

A positive or negative cross effect.

If the two variables are complementary, the first effect is reinforced.

If the two variables are substitutes, the substitution effect can overperform the first effect and lead to a decrease in one of the variables. The global effect can be negative for one of the variables if there exists an important gap between the efficiency of the two tools of risk reduction.

2.3 Risk Perception and Prevention

In this section, we study the impact of the form of the probability transformation function φ on the individually optimal prevention level h. More precisely, we compare the level of prevention of a realistic individual, that is, $\varphi(p) = p$ with the level of a pessimistic one.

We first consider the case when the savings level s is given. We obtain the following result.

Proposition 2 *Consider 2 individuals differing only in their probability transformation functions, denoted by φ_1 and φ_2. Then, for a fixed level of savings, $h_2^* > h_1^* \Leftrightarrow \varphi_2'(1 - p(h_2^*)) > \varphi_1'(1 - p(h_2^*))$.*

Proof. et us denote by $V_{h_t}^i(h_t)$, $i = 1, 2$ the first order condition (4) for individual i. $h_2^* > h_1^* \Leftrightarrow V_{h_t}^1(h_2^*) < 0 \Leftrightarrow V_{h_t}^1(h_2^*) < V_{h_t}^2(h_2^*)$ which for fixed s is true for $\varphi_2'(1-p(h_2^*)) > \varphi_1'(1-p(h_2^*))$ because $p'(h_t)\left[U(d_{t+1} - m, \underline{H}) - U\left(d_{t+1}, \overline{H}\right)\right] > 0$ for any h_t and d_{t+1}. ■

To interpret the previous condition we have to distinguish two types of pessimists: the moderate and the fatalists.

Definition 1 *An individual with a convex probability transformation function φ is called* ***fatalist*** *if, for any $p \in [0,1]$, $\varphi'(p) < 1$.*

Fatalists are thus a special kind of pessimists, who perceive the probability of the disease as being relatively stable and do not trust in its possible reduction by preventive measures. More generally, those individuals underestimate probabilities modification and by the same way, underestimate prevention efficiency.

Note moreover that for this property ($\varphi'(p) < 1$) to be satisfied for a convex φ and for any $p \in [0,1]$, it is necessary that the probability transformation function presents discontinuities in 0 and/or in 1. These discontinuities are plausible and justified by the well known potentiel and certainty effects. In the class of strong risk averse individuals ($\varphi''(p) \geq 0$), $\varphi'(p) < 1$ can be satisfied if the individual strongly undesetimates probabilies close to 1 and thus has preferences involving a certainty effect.

Definition 2 *An individual with a convex probability transformation function φ is called* ***moderate pessimist*** *if there exists $\overline{p} \in [0,1]$ such that, for any $p < \overline{p}$, $\varphi'(p) < 1$ and for any $p \geq \overline{p}$, $\varphi'(p) \geq 1$.*

Moderate pessimists are another kind of pessimists who can overestimate probabilities modification and by the same way, the prevention efficiency.

Definition 3 *An individual with $\varphi(p) = p$ (and thus $\varphi'(p) = 1$) for any $p \in [0,1]$ is called* ***realist****.*

We now compare the optimal prevention level of fatalists, moderate pessimists and realists. The results are summarized in the following proposition:

Proposition 3 *Consider a realist, a moderate pesimist and a fatalist with optimal prevention levels respectively denoted h^r, h^{mp} and h^f. $p(h) \in [p(w),\ p(0)]$. Then,*

(i) $h^r > h^f$;

(ii) $p(0) < \overline{p} \Rightarrow h^r < h^{mp}$;

$p(w) > \overline{p} \Rightarrow h^r > h^{mp}$;

$p(w) \leq \overline{p} \leq p(0) \Rightarrow$ both $h^r < h^{mp}$ and $h^r > h^{mp}$ are possible.

Proof. Direct consequence from Proposition 2. ■

Consequently, for $p(0) < \overline{p}$, it is possible to order the prevention levels of the fatalists, realists and moderate pessimists in the following way: $h^{mp} > h^{r} > h^{f}$.

Consider now the case where s is not fixed. To determine the impact of risk perception on both s and h, it is necessary to make additional assumptions about the complementarity or substituability between s and h.

Proposition 4 *Consider 2 individuals differing only in their probability transformation functions, denoted by φ_1 and φ_2.*

(i) If $U''_{cH}(c,H) \leq 0$ (s and h are substitutes), then $s_1 > s_2$ and $h_2 > h_1$ if $\varphi_1(p) > \varphi_2(p)$ for any $p \in [0,1]$ and $\varphi'_2(1-p(h^*_2)) > \varphi'_1(1-p(h^*_2))$.

(ii) If $U''_{cH}(c,H) > 0$ (s and h could be subsitutes or complements), then $s_1 > s_2$ and $h_2 > h_1$ if $\varphi_2(p) > \varphi_1(p)$ for any $p \in [0,1]$ and $\varphi'_2(1-p(h^*_2)) > \varphi'_1(1-p(h^*_2))$.

Proof. rom optimal condition (3), we obtain an implicit function $s(h)$ and thus, from optimal condition (4), we obtain an implicit function of h denoted by $V_h^{\varphi}(s(h),h) = 0$ when the transformation function is φ. Remark that V_h^{φ} is a deacreasing function of h.

Then, we obtain that $h_2 > h_1$ iff $V_h^{\varphi_2}(s_2(h_2),h_2) > V_h^{\varphi_1}(s_1(h_2),h_2)$.

(i) Suppose $U''_{cH}(c,H) \leq 0$ then $s_1(h) > s_2(h)$ if $\varphi_1(p) > \varphi_2(p)$ for any $p \in [0,1]$. Consequently, the above inequality is verified under the condition $\varphi'_2(1-p(h^*_2)) > \varphi'_1(1-p(h^*_2))$.

(ii) Suppose $U''_{cH}(c,H) > 0$, then $s_1(h) > s_2(h)$ if $\varphi_1(p) < \varphi_2(p)$ for any $p \in [0,1]$.

and the above inequality is verified under the condition $\varphi'_2(1-p(h^*_2)) > \varphi'_1(1-p(h^*_2))$. ■

Consequently, if we compare the optimal prevention and savings for a moderate pessimist and for a realist, due to $\varphi^{mp}(p) < p$, if savings and prevention are substitutes and $\varphi'^{mp}(p) > 1$,we obtain $s_r > s_{mp}$ and $h_r < h_{mp}$. On the other hand, if we compare the optimal prevention and savings for a fatalist and for a realist, due to $\varphi^{f}(p) < p$ and $\varphi'^{f}(p) < 1$, if savings and prevention are complements, we obtain $s_f > s_r$ and $h_f < h_r$. In the case where savings and prevention are subsitute, we can not obtain a unambiguous result. Indeed, two opposite effects can be distinguished: firstly, pessimism incites individuals to decrease their level of savings and thus to increase their level of prevention; secondly, fatalism incites individuals to decrease their level of prevention. Finally, the total effect of risk perception is not clear.

The previous result shows that the investment in prevention is related more to the sensibility of the probability perception to a modification in probability than to risk aversion and pessimism. Indeed, the property $\varphi_2'(p) < 1$ can be verified both for pessimistic and for optimistic individuals. Efficiency of prevention is then percieved as low which decreases prevention demand.

Numerical example

In this example, we compare the optimal prevention choices of three agents, differing only in risk perception: a moderate pessimist, a fatalist and a realist with the following probability transformation functions $\varphi_{mp}(p) = p^2, \varphi_f(p) = \frac{1}{4}p^2, \varphi_r(p) = p$ represented in figure 1.

The utility function of the agents is assumed to be separable and the utility for wealth is CRRA, namely: $u(c, H) = \frac{c^{1-\alpha}}{1-\alpha} + v(H)$.

The illness probability depends on prevention expenses in the following way: $p(h) = \frac{1}{1.2+h}$. $p(h)$ verifies all the required properties and corresponds to a large probability range, more precisely, for $h \in [0,\ 100]$, $p(h) \in [0.0099,\ 0.83]$.

The following values are given to the other parameters of the model:
$w = 100,\ R = \delta = 1,\ s = 0.15w$.

We compare the optimal prevention levels of the three types of agents for different values of the treatment cost $m = ts$. Two cases are considered for the parameter of the CRRA utility function: $\alpha = 2$ and $\alpha = 4$.

- For $\alpha = 2$

$t = m/s$	h^r	h^{mp}	h^f
0.7	23,18	29,33	17,19
0.5	16,49	21,48	11,66
0.2	8,65	11,66	5,49
0.1	5,63	7,66	3,17
0.01	0.98	1,12	0
0.008	0.75	0.70	0
0.007	0.63	0	0
0.001	0	0	0

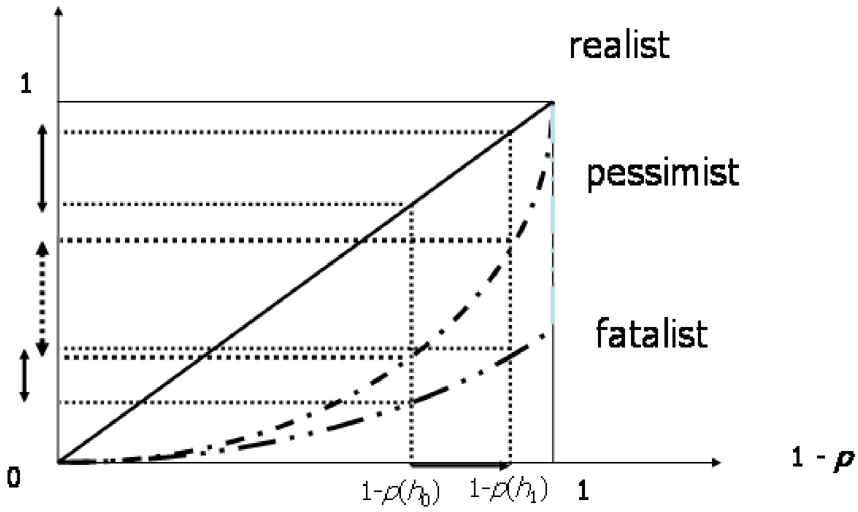

Figure 1:

The following table gives the corresponding illness probability levels.

$t = m/s$	p^r	p^{mp}	p^f
0.7	0,04	0,03	0.05
0.5	0.06	0,04	0.08
0.2	0,10	0,08	0,15
0.1	0,15	0,11	0,23
0.01	0,46	0,43	0,83
0.008	0,51	0,53	0,83
0.007	0.63	0,83	0,83
0.001	0,83	0,83	0,83

- $\alpha = 4$

$t = m/s$	h^r	h^{mp}	h^f
0.7	54,45	58,32	50,00
0.5	43,68	48,32	38,50
0.2	29,11	34,00	23,90
0.1	22,48	27,00	18,00
0.01	8,87	11,53	6,00
0.0003	0,90	1,00	0
0.00025	0.73	0,66	0
0.0002	0,54	0	0

$t = m/s$	p^r	p^{mp}	p^f
0.7	0,02	0,017	0,019
0.5	0,022	0,020	0,025
0.2	0,033	0,032	0,04
0.1	0,042	0,035	0,052
0.01	0,10	0,078	0,14
0.0003	0,48	0,45	0,83
0.00025	0,52	0,54	0,83
0.0002	0,57	0,83	0,83

First, as we proved previously, fatalists make less prevention than moderate pessimists and realists. For the comparaison between moderate pessimists and realists, it is more ambiguous. The numerical example illustrates the case where $p(w) \leq \overline{p} \leq p(0)$. We obtain that for small m, moderate pessimists invest less than realists although, from a level of m, they invest more than realists. Consequently, we can not obtain a general result.

3 Equilibrium

In this section we characterize the long term competitive equilibrium in the economy.

We consider an overlapping generation model. We assume a constant population, at each period, a new generation of N agents is born. There is a neoclassical production sector which produces one good using capital and labor and a health production sector.

3.1 The firms

We consider perfectly competitive firms. Production occurs within a period according to a constant returns to scale production function using two inputs, labour, L_t, and capital, K_t: $Y_t = F(K_t, L_t)$. Let denote by f, the function defined by $f(k_t) = F\left(\frac{K_t}{L_t}, 1\right)$. Function $f(.)$ is assumed twice continuously differentiable and we make the usual hypothesis:

Assumption A3.

- *For all* $k > 0$, *one has* $f(k) > 0$, $f'(k) > 0, f''(k) < 0$.
- $f(0) = 0$.
- Inada conditions hold: $\lim_{k \to 0} f'(k) = +\infty$ and $\lim_{k \to +\infty} f'(k) = 0$.

We suppose that capital fully depreciates during the production process. Firms takes prices, w_t and R_t as given and maximize profits.

The optimal input levels are obtained by equalizing the marginal productivity of production factors with their cost:

$$\begin{aligned} w_t &= F'_L(K_t, L_t) \\ R_t &= F'_K(K_t, L_t). \end{aligned} \tag{9}$$

3.2 The Government

We consider that population is divided into n groups with respect to risk perception. We suppose that there is a fixed proportion π^i of agents of type i, $i = 1$ to n. From a macroeconomic view, $\sum_{i=1}^{n} N\pi^i p\left(h_{t-1}^i\right)$ represents the proportion of agents born at period $t-1$ who become sick at period t.

The marginal cost of treatment, denoted by T, depends on the number of patients. For some pathologies, the cost admits some decreasing returns to scale. For others, it can be an increasing function of the number of patients. In this model, we take into account this relation by assuming that $T = T\left(\sum_{i=1}^{n} N\pi^i p\left(h_{t-1}^i\right)\right)$ but to preserve generality, the sign of $T'\left(\sum_{i=1}^{n} N\pi^i p\left(h_{t-1}^i\right)\right)$ is not specified.

As the part of treatment cost supported by the patient is supposed a percent of total cost, it also depends on the number of patients, $m = tT\left(\sum_{i=1}^{n} N\pi^i p\left(h_{t-1}^i\right)\right)$.

The government's budget constraint writes:

$$N\tau_t = N\sum_{i=1}^{n} \pi^i p\left(h_{t-1}^i\right)(1-t)\,T\left(\sum_{i=1}^{n} N\pi^i p\left(h_{t-1}^i\right)\right).$$

3.3 Equilibrium at steady state

We now characterize the equilibrium level of savings and prevention at steady state.

The steady state is defined by a stationary stock of capital for all type of individuals, $\widehat{k}^i$, and a stationary distribution of $\widetilde{d}^i$ that is a stationary proportion $p\left(\widehat{h}^i\right)$ of individuals who become sick for each generation of type i which verify

$$\widehat{k}^i = \pi^i \widehat{s}^i\left(F_L'\left(\widehat{k},1\right), \tau, F_K'\left(\widehat{k},1\right), m\right) \tag{10}$$

$$\text{where } \widehat{k} = N\sum_{i=1}^{n} \pi^i \widehat{k}^i$$

By denoting $\widehat{c}^i$ and $\widehat{d}^i$ the the first period and second (healthy) period consumptions at steady state for agents of type i, steady state equilibrium verifies:

$$-U_c'\left(\widehat{c}^i\right)+\delta f'\left(\widehat{k}\right)\left[\left[1-\varphi_i\left(1-p\left(\widehat{h}^i\right)\right)\right]U_d'\left(\widehat{d}^i-m,\underline{H}\right)\right. \quad (11)$$
$$\left.+\varphi_i\left(1-p\left(\widehat{h}^i\right)\right)U_d'\left(\widehat{d}^i,\overline{H}\right)\right]=0$$

$$-U_c'\left(\widehat{c}^i\right)+\delta\varphi_i'\left(1-p\left(\widehat{h}^i\right)\right)p'\left(\widehat{h}^i\right)\left[U\left(\widehat{d}^i-m,\underline{H}\right)-U\left(\widehat{d}^i,\overline{H}\right)\right]=0 \quad (12)$$

where $\widehat{c}^i=F_L'\left(\widehat{k},1\right)-\sum_{i=1}^n\pi^i p\left(h^i\right)(1-t)\,T\left(\sum_{i=1}^n N\pi^i p\left(h^i\right)\right)-\widehat{k}^i-\widehat{h}^i$ and $\widehat{d}^i=F_K'\left(\widehat{k},1\right)\widehat{k}^i$.

4 The Social Optimum

We suppose that the reimbursement rate, t, is given. Then, we analyze a second best optimal solution at long term. We denote by k^{i*}, c^{i*}, d^{i*}, h^{i*} the optimal levels of, respectively, the stock of capital, the first and second period consumptions and health primary prevention of individuals of type i.

4.1 Characterization

The central planer problem writes:

$$\max_{c^i,d^i,h^i,k^i} N\sum_{i=1}^n \pi^i\left[U\left(c^i,H\right)+\delta\left(1-\varphi_i\left(1-p\left(h^i\right)\right)\right)U\left(d^i-tT,\underline{H}\right)\right.$$
$$\left.+\delta\varphi_i\left(1-p\left(h^i\right)\right)U\left(d^i,\overline{H}\right)\right] \quad (13)$$

subject to the resource constraint per capita

$$y = f\left(N\sum_{i=1}^n\pi^i k^i\right)=\sum_{i=1}^n N\pi^i\left(c^i+h^i+d^i+k^i\right) \quad (14)$$
$$+\sum_{i=1}^n N\pi^i p\left(h^i\right)(1-t)\,T$$

with $T=T\left(\sum_{i=1}^n N\pi^i p\left(h^i\right)\right)$.

Let us denote by μ the Lagrange multiplier associated to the constraint.

The interior solution verifies:

- For the first period consumption

$$U_c'\left(c^i, H\right) = \mu \quad \forall i = 1 \text{ to } n \tag{15}$$

- For the second period consumption, for all $i = 1$ to n :

$$\delta\left[\left(1-\varphi_i\left(1-p\left(h^i\right)\right)\right)U_d'\left(d^i-m,\underline{H}\right)+\varphi_i\left(1-p\left(h^i\right)\right)U_d'\left(d^i,\overline{H}\right)\right]=\mu \tag{16}$$

- For capital

$$f'(k) = 1 \tag{17}$$

- For health prevention

$$\begin{aligned}
&\delta\varphi_i'\left(1-p\left(h^i\right)\right)p'\left(h^i\right)\left[U\left(d^i-m,\underline{H}\right)-U\left(d^i,\overline{H}\right)\right] \\
&-\delta Np'\left(h^i\right)\times tT'\left(\sum_{i=1}^n N\pi^i p\left(h^i\right)\right)\times\sum_{j=1}^n \pi^j\left(1-\varphi_j\left(p\left(h^j\right)\right)\right)U_d'\left(d^j-m,\underline{H}\right) \\
&=\mu\left[1+p'\left(h^i\right)(1-t)\,T\left(\sum_{i=1}^n N\pi^i p\left(h^i\right)\right)\right. \qquad (18)\\
&\left.+Np'\left(h^i\right)\times(1-t)\,T'\left(\sum_{i=1}^n N\pi^i p\left(h^i\right)\right)\times\sum_{j=1}^n \pi^j p\left(h^j\right)\right] \quad \forall i=1 \text{ to } n
\end{aligned}$$

with $m = tT\left(\sum_{i=1}^n N\pi^i p\left(h^i\right)\right)$

Note that equations (15) imply that first period consumption is the same for each agent, $\forall i = 1$ to n, $c^{i*} = c^*$. Difference between agents comes from the repartition of the non consumed part of the wage between health prevention and savings.

We obtain the following characterization of the first-order conditions.

- Trade-off between generations

$$\begin{aligned}
U_c'(c^*, H) &= \delta\left[\left(1-\varphi_i\left(1-p\left(h^{i*}\right)\right)\right)U_d'\left(d^{i*}-m^*,\underline{H}\right)\right. \qquad (19)\\
&\quad \left.+\varphi_i\left(1-p\left(h^{i*}\right)\right)U_d'\left(d^{i*},\overline{H}\right)\right] \\
\text{for } i &= 1,...,n
\end{aligned}$$

- Golden rule

$$f'(k^*) = 1 \tag{20}$$

- Trade-off between prevention and capital

$$\begin{aligned} & \delta\varphi_i'\left(1-p\left(h^{i*}\right)\right)p'\left(h^{i*}\right)\left[U\left(d^{i*}-m^*,\underline{H}\right)-U\left(d^{i*},\overline{H}\right)\right] \\ & -\delta Np'\left(h^{i*}\right)\times tT'^{*}\times\sum_{j=1}^{n}\pi^{j}\left(1-\varphi_j\left(p\left(h^{j*}\right)\right)\right)U_d'\left(d^{j*}-m^*,\underline{H}\right) \\ = & \left[1+p'\left(h^{i*}\right)(1-t)\times\left[T^*+T'^{*}\times\sum_{j=1}^{n}\pi^{j}p\left(h^{j*}\right)\right]\right]U_c'\left(c^{i*},H\right) \\ \text{for } i = & \ 1,...,n. \end{aligned} \tag{21}$$

Comparing equations (11), (12), (19), (20) and (21), we obtain that health prevention level is sub-optimal in the competitive equilibrium, $\widehat{h}^i < h^{i*}$. This is due to the presence of externality and to suboptimality of Nash noncooperative games equilibria. When agents make prevention, it reduces the number of agents who will become sick and thus it reduces the global cost of treatment for a fixed marginal cost. Consequently, the government budget is balanced for a smaller amount of taxes that increases agents welfare. Moreover, the presence of externality has to be taken into account: reducing the number of agents who become sick leads to a change in the marginal cost of treatment. According to the sense of variation which we did not specify, we can obtain a positive or negative effect on the global cost of treatment.

On the other hand, we can show that if health prevention and savings are substitute, there is over-accumulation of capital, $\widehat{k}^i > k^{i*}$, and if health prevention and savings are complementary, there is under-accumulation of capital, $\widehat{k}^i < k^{i*}$.

We now turn to the problem of reaching social optimum. Several instruments can be used: taxes on wealth, rate of reimbursement, subsidies to prevention expenses etc. As we saw in section 2, the effects of wealth and co-payment (or rate of reimbursement) on the level of prevention can be ambiguous. Thus, it is not sure that increasing wealth or decreasing rate of reimbursement can allow the implementation of the social level of prevention. Consequently, we propose a subsidy system that we analyze under two assumptions: (i) the governement perfectly observes the agents' types (that is their risk perception); (ii) the governement only knows the repartition of types in the economy.

4.2 Decentralization under perfect information

Internalizing the externality implies an optimal level of health prevention that is larger than obtained in the *laissez-faire* setting. To reconcile the decentralized choices and the efficient allocation, one can subsidize the agents' level of health prevention. To finance these subsidies, the government increases taxes on wage such that the government's budget is balanced:

$$N\tau = N\sum_{i=1}^{n}\pi^{i}p\left(h^{i}\right)(1-t)\,T\left(\sum_{i=1}^{n}N\pi^{i}p\left(h^{i}\right)\right)+N\sum_{i=1}^{n}\pi^{i}\theta^{i}h^{i}, \tag{22}$$

with θ^{i} the agent i's subsidy.

We consider an optimal steady state $c^{*}, d^{i*}, h^{i*}, k^{i*}$ satisfying equations (19), (20) and (21).

Proposition 5 *At steady state, social optimum can be implemented in a market economy with specific subsidies to health prevention defined by*
$\theta^{i*}=\frac{-p'\left(h^{i*}\right)}{u_c'(c^{*})}\times A\left(\theta^{i*},\theta^{-i*}\right)$
where $A\left(\theta^{i*},\theta^{-i*}\right)=\delta tT'^{*}\times\sum_{j=1}^{n}N\pi^{j}\left(1-\varphi_{j}\left(p\left(h^{j*}\right)\right)\right)\times U_{d}'\left(d^{j*}-m^{*},\underline{H}\right)$
$+(1-t)\,u_c'\left(c^{*}\right)\left[T'^{*}\times\sum_{j=1}^{n}N\pi^{j}p\left(h^{j*}\right)+T^{*}\right]$
and taxes $\tau^{*}=\sum_{i=1}^{n}\pi^{i}p\left(h^{i*}\right)(1-t)\,T^{*}+\sum_{i=1}^{n}\pi^{i}\theta^{i*}h^{i*}$.

Proof. he introduction of the subsidy modifies the agents' budget constraint in the following way: $w-\tau=c+s+(1-\theta)h$. Thus, the first order condition characterizing the equilibrium (12) becomes:

$$-(1-\theta)\,U_c'(c,H)+\delta\varphi'(1-p(h))\,p'(h)\left[U\left(d-m,\underline{H}\right)-U\left(d,\overline{H}\right)\right]=0 \tag{23}$$

The central planner has to fix the subsidy in order to implement the solution of (21). A direct calculus gives us the amount of the subsidy and the amount of the tax. ■

The sign of subsidies depends on the sign of the expression $A\left(\theta^{i*},\theta^{-i*}\right)$ which is the same for each agent. This expression measures in some sense the degree of sub-optimality.

More precisely, sub-optimality exists for two reasons.

The first reason is the benefit due to the decrease in taxes when prevention is made by some agents. This effect can be measured by $(1-t)\,T^{*}$ which is always positive. In our analyze, the level of the individual co-payment rate is given. If public authority could use this instrument and decides to impose the total cost to individuals by setting $t=100\%$, the first effect would disappear. Else, we show that, for any level of reimbursement, $1-t>0$, subsidies θ^{i*} are increasing functions of $(1-t)$.

The second reason is the presence of an externality which effect is measured by $T'^{*}\times\Big[\delta t\times\sum_{j=1}^{n}N\pi^{j}\left(1-\varphi_{j}\left(p\left(h^{j*}\right)\right)\right)\times U_{d}'\left(d^{j*}-m^{*},\underline{H}\right)$
$+\left(1-t\right)u_{c}'\left(c^{*}\right)\times\sum_{j=1}^{n}N\pi^{j}p\left(h^{j*}\right)\Big]$. As the expression between brackets is strictly positive, the sense of this second effect depends on the sign of T'^{*} which can be positive or negative. If, treatment cost admits some decreasing returns to scale, $T<0$ and subsidies become negative if this second effect is higher than the first one. If treatment cost is an increasing function of the number of patients, the two effects are positive and subsidies are always positive.

Finally, subsidies are proportional to the efficiency of prevention measured by the change in probability due to a change in health prevention investment, $-p'\left(h^{i*}\right)$. Suppose that an improvement in the technology leads to an increase in the efficiency of prevention. This can be modelized by a change in the probability of illness, *ceteris paribus.* The socially optimal prevention level then increases and thus, in order to implement it, subsidies have to be higher (if they are positive).

4.3 Asymetric information

In this section, we will look at subsidy system when the type of agents is unobservable Government only knows the repartition of the population and then has to fix a unique subsidy, θ, which verifies the following government's program:

$$\max_{c^i,d^i,k^i,\theta} N\sum_{i=1}^{n}\pi^i\left[U\left(c^i,H\right)+\delta\left(1-\varphi_i\left(1-p\left(h^i\left(\theta\right)\right)\right)\right)U\left(d^i-tT,\underline{H}\right)\right. \tag{24}$$
$$\left.+\varphi_i\left(1-p\left(h^i\left(\theta\right)\right)\right)U\left(d^i,\overline{H}\right)\right]$$

subject to the resource constraint per capita (μ)

$$y = f\left(N\sum_{i=1}^{n}\pi^i\widehat{k}^i\right)=\sum_{i=1}^{n}N\pi^i\left(c^i+h^i\left(\theta\right)+d^i+k^i\right) \tag{25}$$
$$+\sum_{i=1}^{n}N\pi^ip\left(h^i\left(\theta\right)\right)\left(1-t\right)T$$

with $T=T\left(\sum_{i=1}^{n}N\pi^ip\left(h^i\left(\theta\right)\right)\right)$ and where $h^i\left(\theta\right)$ is the best response in term of prevention of agent of type i to a subsidy θ:

$$-U_c'\left(c^i\right)+\delta f'\left(k\right)\left[\left[1-\varphi_i\left(1-p\left(h^i\left(\theta\right)\right)\right)\right]U_d'\left(d^i-m,\underline{H}\right)+\varphi_i\left(1-p\left(h^i\left(\theta\right)\right)\right)U_d'\left(d^i,\overline{H}\right)\right]=0 \tag{26}$$

$$-\left(1-\theta\right)U_c'\left(c^i\right)+\delta\varphi_i'\left(1-p\left(h^i\left(\theta\right)\right)\right)p'\left(h^i\left(\theta\right)\right)\left[U\left(d^i-m,\underline{H}\right)-U\left(d^i,\overline{H}\right)\right]=0 \tag{27}$$

We obtain that optimal subsidy verifies:

$$\theta^*=-\frac{\sum\pi^ih^{i\prime}\left(\theta^*\right)p'\left(h^i\left(\theta^*\right)\right)}{\sum\pi^ih^{i\prime}\left(\theta^*\right)U_c'\left(c^*,H\right)}\times A\left(\theta^*\right) \tag{28}$$

where $A\left(\theta^*\right)=\delta tT'^*\times\sum_{j=1}^{n}N\pi^j\left(1-\varphi_j\left(p\left(h^{j*}\right)\right)\right)\times U_d'\left(d^{j*}-m^*,\underline{H}\right)+\left(1-t\right)\left[T'^*\times\sum_{j=1}^{n}N\pi^jp\left(h^{j*}\right)+T^*\right]$.

Let us make some comments. As in the case of perfect information, the sign of subsidy depends on the type of the externality which gives the sign of T'^*.

Let us rank the previous subsidies $\theta^{1*}<\theta^{2*}<....<\theta^{n*}$, we can easily show that subsidy in asymetric information is in the interval $\left[\theta^{1*},\theta^{n*}\right]$. Moreover, it comes that if the proportion of fatalists increase, the subsidy increases too.

Finally, suppose that an improvement in the technology leads to an increase in the efficiency of prevention. As in the perfect information case, optimal prevention level increases and subsidies have to be higher.

5 Conclusion

The objective of this paper was to better understand the determinants of primary prevention and to analyze its socially optimal level. In a first part, we analyzed the simultaneous demands for prevention and savings. We have shown that determinants of these two decisions variables strongly depend on the interaction between them (complementary or subsitute goods). We focused our discussion on the existence of a type of individuals that we call *fatalists*. These individuals are so pessimist that they consider that prevention is inefficient and they decide to not much invest in health prevention. In a second part, considering the existence of a public health insurance, the *laissez-faire* equilibrium leads to a lower level of prevention for any interaction between prevention and savings. We showed that for any existing co-payment rate level, we can decentralize the social optimum by taxes and subsidies under perfect information. the problem of the presence of fatalists is crucial when government can not distinguish them. In this case, we proposed a subsidies system. The disadvantage of this incentive tool is its high cost when the proportion of the fatalists in the population is large. The important question is then to determine if a decrease of cure costs is not a less expensive policy. We could answer this question by extending our model. We have to explicit medical care costs and compare the benefit of a decrease in medical care costs and the benefit of an increase in prevention on welfare.

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