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Optimal Secondary Prevention and Background Risk

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ABSTRACT

This paper examines in the context of a one-period model the impact of background risk on the optimal secondary prevention. We conduct our study based on various configurations of the background risk. We intend to show that in most cases the level of secondary prevention effort varied after the introduction of background risk, however, in very few cases this level remains constant.

Keywords: *Secondary prevention, Background risk*

1. INTRODUCTION

In 1948, the World Health Organization (WHO) defined prevention as: "a set of measures to avoid or reduce the number and severity of illnesses, injuries and disabilities." Prevention as such has been classified into three types:

- Primary prevention is the set of actions aimed at reducing a disease incidence or rate in a population,
- Secondary prevention is to reduce the spread of a disease in a population
- Tertiary prevention intervenes to reduce relapse.

The literature on prevention dating from the early work of Ehrlich and Becker (1972) and the principal works of these authors is based on the study of preventive individual behavior and the impact of insurance on these behaviors.

Moreover, a series of papers elaborated the role of risk aversion on the demand for prevention (see e.g. Dionne and Eeckhoudt, 1985; Briys and Schlesinger, 1990; Julien et al.,1999). Recently, some papers studied the effect of prudence on optimal prevention (see Chiu, 2005; Eeckhoudt and Gollier, 2005; Menegatti, 2009). A large amount of literature found that economic decisions are facing a single source of risk when in reality they are facing several sources. So many authors have focused on the analysis of individual behaviors with respect to other risks and shown that the introduction of a background risk affects many economic decisions (see e.g. Doherty and Schlesinger, 1990; Gollier and Pratt, 1996; Eeckhoudt et al., 1996; Hau, 1999; Rey, 2003).

Surprisingly, no work, to the best of our knowledge, has addressed the issue of secondary prevention in the presence of background risk. This paper tries to ll this gap.

In this paper, we look at how the introduction of a background risk modifies the optimal level of secondary prevention. Considering the three forms of background risk, we intend to show that results differ depending on both the configuration of the background risk and and/or risk aversion.

The organization of this article is as follows. The next section introduces the model. The section that follows examines the optimal secondary prevention without background risk versus the one-period model with background risk. The last section concludes.

2. THE MODEL

We consider the model d'Eeckhoudt and Gollier (2005) suggesting as a model secondary prevention in a one-period setting; we suppose that the decision to engage in prevention activity and its effect on the loss function $l(e)$ are simultaneous.

The agent selects the effort level of secondary prevention e in order to maximize his total inter-temporal utility $V(e)$. His total utility is given by:

$$V(e) = pv(w_0 - l(e) - e) + (1 - p)v(w_0 - e) \qquad (1)$$

Where v is the utility function, we assume that the individual is risk averse $v'' < 0$. The effort level of secondary prevention is e, its effects are described in the following loss function: $l(e)$, we assume that $l'(e) < 0$, since the increase in effort of prevention leads to a decrease in the loss l and $l''(e) > 0$, w_0 is the safe wealth.

The first-Oder condition (FOC) for a maximum writes as $V'(e^*) = 0$, which is equivalent to:

$$V'(e^*) = p(-l'(e) - 1)v'(w_0 - l(e) - e) - (1 - p)v'(w_0 - e) = 0 \qquad (2)$$

$$-p(l'(e) + 1)v'(w_0 - l(e) - e) = (1 - p)v'(w_0 - e) \qquad (3)$$

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whether $(1-p)\,v'(w_0-e)>0$,

therefore

$-p\,(l'(e)+1)\,v'(w_0-l(e)-e)>0$

$p>0$ and $v'(w_0-l(e)-e)>0$

Thus $l'(e)+1<0 \Longleftrightarrow l'(e)<-1$

The left part of equation (3): $(1-p)v'(w_0-e)$, represents the marginal cost of secondary prevention. It represents the loss of utility associated with the practice of secondary prevention. The right part of equation (3): $-p\,(l'(e)+1)v'(w_0-l(e)-e)$ is the marginal benefit of secondary prevention. It expresses the expected gain of the utility due to the reduction of loss.

The second order condition $(V''(e)<0\ \forall e)$ is equivalent to:

$$V''(e)=-p[l''(e)v'(w_0-l(e)-e)]+p[(l'(e)+1)^2v''(w_0-l(e)-e]+(1-p)v''(w_0-e)<0 \tag{4}$$

The second-order condition is satisfied

In the next section, we will study the impact of introducing background risk on the level of the effort of secondary prevention. The introduction of a background risk can take various forms. The background risk can be in the first period in general. It can also be a state-dependent background risk.

3. THE ONE-PERIOD MODEL OF SECONDARY PREVENTION WITHOUT BACKGROUND RISK VERSUS THE ONE-PERIOD MODEL WITH BACKGROUND RISK

The following general expression in the presence of background risk becomes:

$$V_g(e)=p[E(v(w_0-l(e)-e+\tilde{\varepsilon}_{0b}))]+(1-p)[E(v(w_0-e+\tilde{\varepsilon}_{0g}))] \tag{5}$$

Where E denotes the expectation operator over the random variables $\tilde{\varepsilon}_k\ (k=0b,0g)$

3.1 The One-Period Model of Secondary Prevention with Background Risk in General

The agent is faced with an additive risk when deciding on his level of secondary prevention. In this case, $\tilde{\varepsilon}_{0b}=\tilde{\varepsilon}_{0g}$ and the problem is equivalent to:

$$V(e)=p[E(v(w_0-l(e)-e+\tilde{\varepsilon}_{0b}))]+(1-p)[E(v(w_0-e+\tilde{\varepsilon}_{0g}))] \tag{6}$$

The optimal level of prevention e^* is given by:

$$V_0'(e^*)=-p[(l'(e)+1)E(v'(w_0-l(e)-e+\tilde{\varepsilon}_{0b})]-(1-p)[E(v'(w_0-e+\tilde{\varepsilon}_{0g})]=0 \tag{7}$$

Comparing the two optimal values, e_0^* and e^* we have:

$$V_0'(e_0^*)=-\{p\,(l'(e)+1)[E(v'(w_0-l(e)-e+\tilde{\varepsilon}_{0b}))-v'(w_0-l(e)-e)]+(1-p)[E(v'(w_0-e+\tilde{\varepsilon}_{0g})-v'(w_0-e))]\} \tag{8}$$

Along with : $l'(e)+1<0$

The sign of this equation is ambiguous. Consequently, the introduction of a background risk can reduce, increase or not change the level of secondary prevention.

Proposition 1

The introduction of a background risk can reduce $(e_1^*\le e^*)$, increase $(e_1^*\ge e^*)$ or not change $(e_1^*=e^*)$ the level of prevention.

3.2 State-Dependent Risk

First, we suppose that the background risk appears in the "bad" state of nature $\tilde{\varepsilon}_{0g}=0$. The problem becomes:

$$V_b(e)=p[E(v(w_0-l(e)-e+\tilde{\varepsilon}_{0b}))]+(1-p)(v(w_0-e)) \tag{9}$$

The optimal level of prevention e_{0b}^* is given by:

$$V_0'(e_{0b}^*)=-p(l'(e)+1)E(v'(w_0-l(e)-e+\tilde{\varepsilon}_{0b}))-(1-p)v'(w_0-e) \tag{10}$$

Comparing the two optimal values e_{0b}^* and e^* we have:

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$$V'_{0b}(e^*_{0b}) = -\{p(l'(e)+1)[E(v'(w_0 - l(e) - e + \tilde{\varepsilon}_{0b}) - v'(w_0 - l(e) - e)]\} \quad (11)$$

This equation is positive for all utility function v such as $v''(.) \leq 0$. Hence the introduction of a background risk in the loss state of nature increases the optimal effort level of prevention $(e^* \leq e^*_{0b})$.

The introduction of a background risk in the loss state of nature affects the marginal benefit of prevention, without modifying its marginal cost. Indeed, for an individual risk averse, the introduction of a background risk in the "bad" state of nature increases the marginal benefit of prevention since

$$p(l'(e)+1)E(v'(w_0 - l(e) - e + \tilde{\varepsilon}_{0b})) \geq p(l'(e)+1)v'(w_0 - l(e) - e))$$

if and only if $v'' \leq 0$, without modifying its marginal cost.

Proposition 2

The introduction of a background risk in the loss state of nature increases the optimal effort level of prevention $(e^* \leq e^*_{0b})$, for all risk averse individuals.

In the case where the risk appears in the good state of nature $\tilde{\varepsilon}_{0b} = 0$, the problem writes as follows :

$$V_g(e) = p(v(w_0 - l(e) - e)) + (1-p)[E(v(w_0 - e + \tilde{\varepsilon}_{0g}))] \quad (12)$$

The optimal level of prevention e^*_{0g} is given by

$$V'(e^*_{0g}) = -p(l'(e)+1)v'(w_0 - l(e) - e) - (1-p)E(v'(w_0 - e + \tilde{\varepsilon}_{0g})) \quad (13)$$

Comparing this optimal effort level to the optimal value without background risk, we have

$$V'_{0g}(e^*_{0g}) = -\{(1-p)[E(v'(w_0 - e + \tilde{\varepsilon}_{0g})) - v'(w_0 - e)]\} \quad (14)$$

This equation is negative. Hence the introduction of a background risk in the good state of nature reduced the optimal effort level of prevention $(e^*_{0g} \leq e^*)$.

Indeed, the introduction of a background risk in the good state of nature increases the marginal cost of prevention of a risk averse individual compared with the situation without background risk since

$$(1-p)E\left(v'(w_0 - e + \tilde{\varepsilon}_{0g})\right) \geq (1-p)v'(w_0 - e)$$

,if and only if $v'' \leq 0$, without modifying its marginal benefit $[\, p(l'(e)+1)(v'(w_0 - l(e) - e)) \,]$.

Proposition 3

The introduction of a background risk in the good state of nature decreases the optimal effort level of prevention $(e^*_{0g} \leq e^*)$, for all risk averse individuals.

4. CONCLUSION

In this paper we looked at how the introduction of a background risk affects optimal secondary prevention with respect to another risk. It has noted that the results are different according to the configuration of background risk and the behavior of individuals depending on the change in the marginal cost of secondary prevention or changes in its marginal benefit.

We found that the introduction of a background risk in a one-period model of secondary prevention in general reduces the level of prevention $(e^*_1 \leq e^*)$. Yet, when the background risk is state-dependent, the introduction of a background risk in the loss state of nature increases the optimal effort level of prevention $(e^* \leq e^*_{0b})$, for all risk averse individuals while it reduced the optimal effort level of prevention $(e^*_{0g} \leq e^*)$ for all risk averse individuals in the good state of nature.

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