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Optimal health insurance contract: Is a deductible useful?

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Abstract

According to insurance theory, agents who have insurance coverage have less incentives to make preventive actions. In this paper, we argue that the optimality of a deductible [Shavell, S., 1979. On moral hazard and insurance, Quarterly Journal of Economics 93, 541–562.] cannot be extended to the health insurance sector.

Keywords: Health insurance; Preventive actions; Ex ante moral hazard; Bi-dimensional; Utility function; Deductible

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1. Introduction

In the different insurance sectors, policy holders can take preventive actions to reduce the probability that the bad state of the world occurs. Insurance theoreticians analyze the consequences of imperfect monitoring of policy holders' preventive actions. Shavell (1979) shows that preventive actions may be discouraged by insurance coverage by reducing the variation of wealth between states of the world. Besides, because of imperfect monitoring of their preventive actions, policy holders cannot internalize the benefits from their actions through a decrease in their insurance premiums. When policy holders choose complete coverage, Shavell proved that no preventive actions are taken. Consequently, insurance

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contracts must contain a deductible in order to implement the optimal trade-off between risk mutualization and incentives to reduce ex ante moral hazard inefficiencies.

This result is consistent with several insurance sectors where goods are replaceable.[1] However, ex ante moral hazard analysis in the field of health insurance has also to take account of health risk specificities. Curative and preventive treatments are not always perfect substitutes as the efficiency of curative treatments often depends on the preventive actions realized before. Health risk and health state are more closed to the *irreplaceable good* problem described by Cook and Graham relative to the goods covered in other insurance sectors.

Consequently, whatever the extent of coverage, preventive actions in this sector have repercussions on the policy holders' expected health state. Even if they are fully insured against medical expenses, they have an incentive to spend to reduce the risk of being ill due to the fact that illness involves a utility loss.

In this paper, we suggest an ex ante moral hazard model where policy holders' preferences are represented by a bi-dimensional utility function, with the health state as the second dimension. Using this sanitary dimension, we show that Shavell's result is not always consistent: the optimal health insurance contract may contain no deductible. The intuition is that a deductible lowers the policy holders' wealths in case of illness and then increases the marginal disutility of expenses in preventive actions because of the decreasing marginal utility function (reflecting risk aversion in the expected utility framework). This effect paradoxically tends to discourage preventive actions.

The first section describes the assumptions of the model, the second section derives the optimal health insurance contract and the third section concludes.

2. Framework

We consider a representative consumer subject to the following assumptions:

- Two states of the world can occur, $\Omega=\{\mathrm{B}, \mathrm{G}\}$. The state *illness* is noted B, and G is the state *good health*. Each state of the world (B or G) is characterized by a pair $(w_\mathrm{B}; h_\mathrm{B})$ and $(w_\mathrm{G}; h_\mathrm{G})$ which define the wealth w and the health state h of the representative consumer in the two states of the world. For simplicity, we consider that health states h_B and h_G are constant, with $h_\mathrm{G}>h_\mathrm{B}$. We note $\Delta h=h_\mathrm{G}-h_\mathrm{B}>0$ the health state loss caused by the disease.
- The probability of illness is denoted p. The consumer can decrease this probability taking preventive actions $e\geq 0$. We assume $p\equiv p(e)$ with $p'(e)\leq 0$ and $p''(e)\geq 0$. We consider a health risk non-deterministic in the sense that: $p(0)<1$ and $\lim_{e\to\infty} p(e)=p_\infty>0$.

These assumptions imply that p' converges to 0. This property implies that the marginal gain of the preventive actions becomes negligible when these preventive actions are high enough.

The two states of the world belonging to the set Ω have two components: a financial risk and a risk of deterioration of the health state. In order to capture this second risk, we use a bi-dimensional utility function to represent the consumer's preferences. The consumer chooses a preventive effort level not only to reduce the financial risk but also to protect against the health state risk.

[1] Replaceable in the sense of Cook and Graham (1977).

Preferences of the consumer are represented by the following utility function, $v(w; h)$ that is assumed to be additively separable:

$$v(w,h) = u(w) + h. \tag{1}$$

This function is increasing and concave in wealth thus capturing risk aversion. The additive form of the utility function allows the avoidance of wealth effects.[2] Besides we assume no risk-aversion in the health dimension in order to show that opposite results can be obtained even though we have a body of assumptions very close to the Shavell's one. This utility function can equally be interpreted as a state-dependent utility function with an additive form (Karni, 1983). We assume too that this function verifies Inada's conditions: $\lim_{w\to\infty} u'(w) = \infty$ and $\lim_{w\to\infty} u'(w) = 0$.

3. Ex ante moral hazard and optimal health insurance contract

Wealth levels in the two states of the world are:

$$w_G \equiv \tilde{w}_G(e,I;\theta) = w_0 - e - \theta I, \quad w_B \equiv \tilde{w}_B(e,I;\theta) = w_0 - e + (1-\theta)I - L$$
$$= \tilde{w}_S(e,I;\theta) + I - L,$$

where I is the indemnity received by policy holders when they fall ill, L the health expenditure level in case of illness and θ is the premium by unit of coverage. In the case of full coverage ($I=L$): $\tilde{w}_G = \tilde{w}_B = w(e, I;\theta)$.

Since we are interested in the problem of ex ante moral hazard, the level of preventive actions is determined by policy holders and is denoted by $\tilde{e}$. The objective of policy holders is to maximize their expected utility:

$$\tilde{e}(I,\theta) = \underset{e}{argmax}\, p \cdot [u(\tilde{w}_B) + h_B] + (1-p) \cdot [u(\tilde{w}_G) + h_G]$$

where $\tilde{e}$ is implicitly defined by the first-order condition of this program:

$$-p' \cdot (u(\tilde{w}_G) - u(\tilde{w}_B) + \Delta h) = pu'(\tilde{w}_B) + (1-p)u'(\tilde{w}_G). \tag{2}$$

In the univaried Shavell's framework (i.e. $\Delta h=0$), the derivative of expected utility with respect to effort level yields:

$$\frac{\mathrm{d}}{\mathrm{d}e}Ev = -p' \cdot (u(\tilde{w}_G) - u(\tilde{w}_B)) - p \cdot u'(\tilde{w}_B) - (1-p) \cdot u'(\tilde{w}_G).$$

Full coverage of the financial risk ($I=L$) implies $u(w_B)=u(w_G)$ and cancels the benefits of preventive effort $\left(\frac{\mathrm{d}}{\mathrm{d}e}Ev<0\right)$. With this bi-dimensional utility function, even though the health insurance premium is

[2] This choice can be justified because the debate on the sign of U_{12} is still open (Rey, 2003).

not reduced because of the monitoring problem, the difference of the health in the two states of the world implies that policy holders only partially internalize the benefit of their preventive actions.

It is interesting to write Shavell's program to characterize the optimal health insurance contract in our bivariate framework. Since interested in the optimum,[3] we have $\theta = p(e)$. This condition means that the optimum analysis takes into account the impact of the effort on the premium, hence the effort level only depends on the coverage I:

$$-p'(e)[u(\tilde{w}_G(e,I;p(e))) - u(\tilde{w}_B(e,I;p(e))) + \Delta h] = p(e)u'(\tilde{w}_B(e,I;p(e))) + (1-p(e))u'(\tilde{w}_G(e,I;p(e))).$$

We denote $\hat{e} \equiv \hat{e}(I)$ the solution in e of the preceding equation. We also define the level of effort for full coverage in the context of imperfect monitoring as $e^* = \hat{e}(L)$.

Expected utility is then computed using $\theta = p(e)$ and the optimal effort done by policy holders $\hat{e}$. By noting $V(I)$, the expected utility with imperfect information is:

$$V(I) = p(\hat{e})[u(\tilde{w}_B(\hat{e},I);p(\hat{e})) + h_B] + (1-p(\hat{e}))[u(\tilde{w}_G(\hat{e},I;p(\hat{e}))) + h_G].$$

The optimal coverage level is given by the maximization of $V(I)$.

$$V'(I) \equiv -\hat{e}'p'[u(\tilde{w}_G) - u(\tilde{w}_B) + \Delta h] - \hat{e}'[pu'(\tilde{w}_B) + (1-p)u'(\tilde{w}_G)] - \hat{e}'p'I[pu'(\tilde{w}_B) + (1-p)u'(\tilde{w}_G)] - p \cdot [pu'(\tilde{w}_B) + (1-p)u'(\tilde{w}_G)] + pu'(\tilde{w}_B).$$

For full coverage, we obtain:

$$V'(L) = -\hat{e}'(L)p'(e^*)Lu'(w(e^*,L;p(e^*))). \tag{4}$$

The sign of $V'(L)$ only depends on the sign of $\hat{e}'(L)$ and we have

$$\hat{e}'(L) = \frac{p'(e^*)u''(w(e^*,L;p(e^*))) - p(e^*)u''(w(e^*,L;p(e^*)))}{p''(e^*)\Delta h - u''(w(e^*,L;p(e^*)))}$$

Proposition 1. *If* $-\frac{u''(w_0 - e^* - p(e^*)L)}{u'(w_0 - e^* - p(e^*)L)} \geq -\frac{p'(e^*)}{p(e^*)}$, *in the neighborhood of full coverage, preventive efforts are increasing with the indemnity level.*

When the indemnity level varies, two effects are seen. The first is the traditional decrease in incentives explained by Shavell: the increase of the indemnity level decreases the marginal benefit of preventive actions. The second one was already present in the Shavell's analysis but was eliminated in the situation of full coverage. When the indemnity level increases, all other things equal, the policy holders become richer when the bad state of the world occurs. This last effect comes from the decrease of the marginal utility function that reduces the cost of preventive actions in the state B.[4] The case $\hat{e}'(L) > 0$ occurs when

[3] No welfare loss is due to positive loading factor.

[4] If preventive actions are not monetary, but rather inseparable from money utility terms, this effect and its consequences do not hold. In this case, the optimal deductible is positive.

the health state variation between both states of the world induces a high effort ($\hat{e}$) to insure that $p'(\hat{e})$ is low enough. Then, the incentives generated by a decrease in the indemnity level are too low and are dominated by the wealth effect that implies an increase in the marginal cost of preventive actions.

Corollary 1. *If the condition within* Proposition 1 *holds, full coverage is optimal.*

4. Conclusion

The goal of this paper was to underline that it is sometimes ill advised to apply traditional insurance models to the health insurance sector. We take into account of the health risk specificities via a bi-dimensional utility function that captures the risk of deterioration of health.

We showed that this second dimension can be a sufficient condition to make policy holders take preventive actions. Our result implies that according to the health state variation intensity, it may be suboptimal to introduce deductibles. We can interpret this result in the following sense: for small diseases, a deductible may be optimal to introduce incentives when the "*natural incentives*" are not strong enough, however for strong disease, full coverage is optimal. In this last case, the introduction of a deductible lowers the incentives by increasing the marginal cost of preventive actions. This result implies that the presence of deductibles must be contingent at the severity of illness.

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