Average willingness to pay for disease prevention with personalized health information

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Abstract

The paper addresses the effect that personalized health information have on the average willingness to pay for disease prevention actions. We show that personalized information about the probability of disease raises the average willingness to pay for: 1) self-insurance actions if wealth and health are complementary and; 2) self-protection actions whatever the interaction between wealth and health. Complementarity between wealth and health combined with cross-imprudence in health is also shown to be sufficient to obtain that personalized information about the severity of disease raises the average willingness to pay for: 1) self-protection actions and; 2) self-insurance actions if individuals are also prudent in health. Empirical and theoretical arguments are exposed to justify the combinations of these conditions.

JEL Classification: D81; I18

Keywords: Personalized health information - Disease prevention - willingness to pay

Introduction

Disease prevention activities usually refer to the efforts made to reduce: 1) the probability of diseases (self-protection or primary prevention) and; 2) the severity of diseases (self-insurance or secondary prevention). The economic analysis of prevention decisions has been introduced by Ehrlich and Becker (1972) who examined the interaction between three instruments (insurance, self-protection and self-insurance) used to cope with financial risks. This important contribution led to a series of theoretical papers on this topic, going from Briys and Schlesinger (1990), who explained why more risk averse agents always invest more in self-insurance actions but not necessarily more in self-protection activities to Chiu (2005), Eeckhoudt and Gollier (2005) and Menegatti (2009), who analyzed the link between self-protection and prudence. These advances in risk theory have been transposed to health economics issues. For instance, the substitution or complementary relationship between therapeutic and preventative medicine is examined in Eeckhoudt, Godfroid and Marchand (2000) while Courbage and Rey (2005) analyzed the determinants of optimal prevention for health risks. Besides the analysis of prevention decisions, an important literature - initiated by Drèze (1964) - has been dedicated to the willingnesses to pay for prevention activities. The effects on this willingness to pay of the baseline death probability, of wealth, of risk aversion and of the presence of comorbidities have been examined by Jones-Lee (1974), Pratt and Zeckhauser (1996), Dachraoui et al. (2004) and Bleichrodt et al. (2003) respectively.

Our paper complements these theoretical developments by examining the effects that personalized health information should have on the willingness to pay for disease prevention. As a matter of fact, the ever growing availability of health-related information (due for instance to the development of genetic testing, to the multiplication of public health campaigns and to the increasing use of internet for medical purposes) changes the way diseases are perceived by individuals and thus their propensity to prevent them[1]. Whether individuals learn that they are particularly vulnerable to some diseases or whether they are reassured by the newly available information, their willingness to pay for reductions in the severity and/or in the probability of diseases should, in theory, be modified. An interesting question related to the development of personalized health information is whether the willingness to pay based on the average information (*i.e.* in the absence of personalized information) is higher than the average willingness to pay for prevention (*i.e.* with personalized information). In this paper, we address this question whose answer determines whether the relevance of prevention program is affected by the development of personalized health information. When the information is about the probability of

[1]Empirical studies support that providing the public with risk information changes individuals' attitude (see for example Hsieh et al. (1996) about the effects of anti-smoking campaigns on smoking behaviour or Barnett et al. (2007) about the public response to the UK government advices about mobile phone health risks).

disease, the research question is related to the consequences of the development of genetic testing. By providing information on individual probabilities of disease, predisposition tests offer the opportunity to better target prevention efforts. Therefore, we address in particular the effects that genetic testing should have on the relevance of disease prevention programs. Note that the issue[2] has been addressed by Snow (2011) who indicates that the intensity of prevention efforts (both self-protection and self-insurance) made by (ambiguity averse) individuals is higher in the presence of ambiguity than in its absence. By removing the ambiguity surrounding the probability of diseases, predisposition tests should thus make individuals less prone to make prevention efforts. However, while Snow (2011) focuses on a pure ambiguity effect by analyzing changes in prevention efforts resulting from the removal of the uncertainty about the probability of disease, we evaluate the average willingness to pay of individuals differing in their baseline probability of disease[3]. The adoption of this different perspective leads to a qualification of the result obtained by Snow (2011). We show that the effects of personalized health information on the average willingness to pay for prevention actions basically depend on the interaction between wealth and health in the utility function, *i.e.* on whether individuals like or dislike the correlation between wealth-related and health-related harms. Specifically, personalized information about the probability of diseases always increases the average willingness to pay for self-protection actions while it increases (resp. reduces) the willingness to pay for self-insurance actions if individuals are correlation prone (resp. correlation averse). When the information is related to the severity of diseases, we show that the joint assumptions of correlation loving and cross-imprudence in health are sufficient to raise the average willingness to pay: 1) for self-protection actions and; 2) for self-insurance actions if individuals are also prudent in health.

Some of our results depend thus on the association of correlation loving and cross-imprudent preferences. Correlation loving corresponds in health economics to the complementarity between wealth and health, a relationship that has been empirically supported by Viscusi and Evans (1990), Sloan et al. (1998) and Finkelstein et al. (2009)[4] among others. Its association with cross-imprudence - which has not been empirically tested yet - is theoretically justified by Eeckhoudt et al. (2007) who show that both preferences indicate that the benefits resulting from favourable health situations (absence of disease, absence of health risk,...etc.) increase as individuals get wealthier. Joining correlation aversion and cross-imprudence is thus plausible since both preferences stem from a more general behavioural trait. Therefore, our conclusions hold under a mix of empirically supported and theoretically justified assumptions.

The paper is organized as follows. The willingnesses to pay for self-protection and for self-insurance are examined in Sections 2 and 3 respectively. In both sections, we sequentially

[2] Even though it is not presented in terms of the development of genetic testing.

[3] However, we assume that there is no aversion towards ambiguity in our model.

[4] Note that the opposite conclusion is reached when minor injuries are considered (see Evans et Viscusi (1991)).

introduce personalized information about the probability (Sections 2.1 and 3.1) and about the severity of diseases (Sections 2.2 and 3.2). Section 4 concludes.

2 Average willingness to pay for self-protection

Consider an expected utility maximizer who derives utility from wealth (w) and health (h), hence $u(w, h)$. The utility function is increasing and concave in both arguments[5] ($u_1(w, h) > 0$, $u_2(w, h) > 0$, $u_{11}(w, h) < 0$ and $u_{22}(w, h) < 0$). No assumption is made about the sign of $u_{12}(w, h)$. A given disease occurs with a probability p and lowers the individual's health status to $h - m$ (where m denotes the severity of the disease). The individual expected utility is given by:

$$\overline{EU} = (1-p)u(w,h) + pu(w,h-m) \tag{1}$$

The willingness to pay (denoted W_p) for a reduction Δ in the probability of disease is defined by the following expression:

$$(1-p)u(w,h) + pu(w,h-m) = (1-p+\Delta)u(w-W_p,h) + (p-\Delta)u(w-W_p,h-m) \tag{2}$$

W_p corresponds to the wealth change which - when coupled with a reduction Δ (with $\Delta > 0$) in the probability of disease - leaves the individual at the constant expected utility $\overline{EU}$. We approximate $u(w - W_p, h)$ and $u(w - W_p, h - m)$ through first-order Taylor expansions around $u(w, h)$ and $u(w, h - m)$ respectively:

$$u(w-W_p,h) \cong u(w,h) - W_p u_1(w,h) \tag{3}$$

$$u(w-W_p,h-m) \cong u(w,h-m) - W_p u_1(w,h-m) \tag{4}$$

Inserting (3) and (4) into (2), we obtain after simplifications the following expression for W_p:

$$W_p \cong \frac{\Delta\left[u(w,h) - u(w,h-m)\right]}{\left[(1-p+\Delta)u_1(w,h) + (p-\Delta)u_1(w,h-m)\right]} = \frac{\Delta\left[u(w,h) - u(w,h-m)\right]}{EU_1} \tag{5}$$

Eq. (5) indicates that W_p is the ratio of the expected marginal benefit of self-protection (*i.e.* increasing by Δ the probability of experiencing the utility level associated to the healthy state instead of the utility level associated to the disease state) to the expected marginal cost of a monetary unit spent (*i.e.* a weighted average of the marginal utilities of wealth in the two states of the world). To ease the notation, the denominator of (5) is henceforth denoted EU_1.

[5] First and second derivatives of the utility function with respect to the first argument (wealth) are respectively denoted by $u_1(w, h)$ and $u_{11}(w, h)$. First and second derivatives of the utility function with respect to the second argument (health) are respectively denoted by $u_2(w, h)$ and $u_{22}(w, h)$. The cross derivative is denoted by $u_{12}(w, h)$.

2.1 Change in the baseline probability of disease

Eq. (6) indicates how the willingness to pay for self-protection changes with the baseline probability of disease.

$$\frac{dW_p}{dp} = \frac{\Delta\left[u(w,h) - u(w,h-m)\right]\left[u_1(w,h) - u_1(w,h-m)\right]}{[EU_1]^2} \tag{6}$$

The sign of (6) is defined by $u_1(w,h) - u_1(w,h-m)$ *i.e.* the sign of $u_{12}(w,h)$. More precisely:

$$\frac{dW_p}{dp} \gtreqless 0 \text{ if } u_{12}(w,h) \gtreqless 0$$

The last inequalities can be explained as follows. If $u_{12}(w,h) < 0$, the marginal utility of wealth is higher in the disease state. Reductions in the probability of disease, by changing the weight associated to the marginal utilities in the two states of the world, raise the expected marginal utility of wealth EU_1 and thus lower the willingness to pay for self-protection. By the same reasoning, the willingness to pay for self-protection rises with the baseline probability of disease if $u_{12}(w,h) > 0$.

Let us now show that – no matter the sign of $u_{12}(w,h)$ – the willingness to pay increases or decreases at an increasing rate (*i.e.* W_p is convex). The shape of the willingness to pay is defined by:

$$\frac{d^2W_p}{dp^2} = \frac{2\Delta\left[u(w,h) - u(w,h-m)\right]\left[u_1(w,h) - u_1(w,h-m)\right]^2}{[EU_1]^3} > 0 \tag{7}$$

The relationship between the willingness to pay for self-protection and the baseline probability of disease when the marginal utility of wealth falls (fig. 1a) and rises (fig. 1b) with health is depicted below.

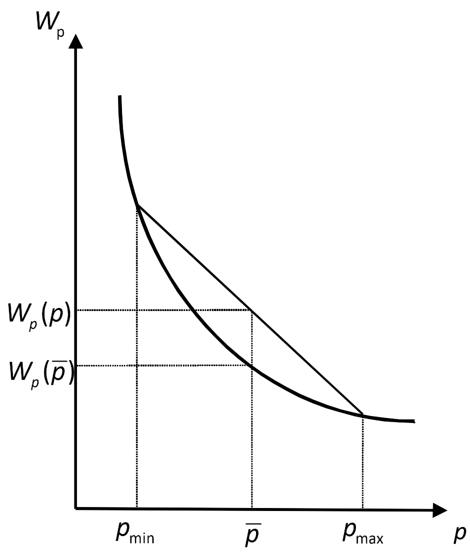

Figure 1a : $u_{12}(w,h) < 0$

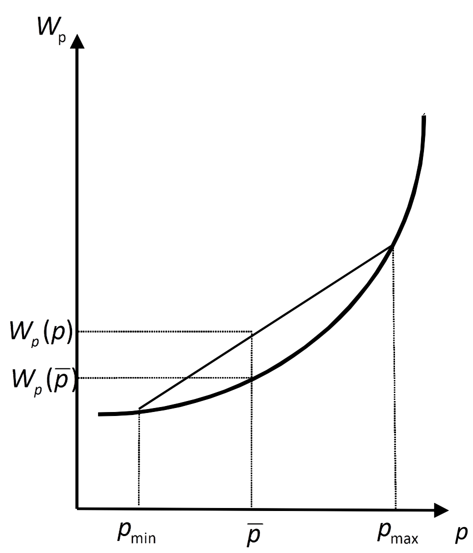

Figure 1b : $u_{12}(w,h) > 0$

The convexity of W_p with respect to the baseline probability of disease can be explained in the following way. Increases in p raise (resp. lower) W_p when $u_{12}(w,h) < 0$ (resp. $u_{12}(w,h) > 0$). These changes have the same impact (given by $u_1(w,h-m) - u_1(w,h)$) on the expected marginal utility of wealth. However, since they occur at different expected marginal utility levels, these (constant) variations in the denominator of (5) do not have the same impact on the ratio defining W_p. Suppose for instance that $u_{12}(w,h) > 0$. In that case, the lower p, the higher the initial expected marginal utility of wealth and the lower the reduction of the marginal expected utility when p rises. If $u_{12}(w,h) < 0$, the lower p, the lower the initial expected marginal utility of wealth and thus the lower the reduction in the expected marginal utility consecutive to an increase in p. In both cases, W_p is convex in p and, using the Jensen inequality, we conclude that the average willingness to pay is higher than the willingness to pay based on the average probability of disease.

From the above reasoning, we expect the development of genetic testing to raise the willingness to pay for self-protection actions.

2.2 Change in the severity of the disease

Let us now address the way information about the severity of the disease modifies the willingness to pay for reductions in the probability of disease. To do so, we first determine the sign of (8).

$$\frac{dW_p}{dm} = \frac{\Delta u_2(w,h-m)EU_1 + \Delta(p-\Delta)\left[u(w,h) - u(w,h-m)\right]u_{12}(w,h-m)}{[EU_1]^2} = \frac{X}{Y} \tag{8}$$

Eq. (8) indicates that the willingness to pay for self-protection rises as the severity of the disease increases if $u_{12}(w,h) > 0$. Increases in m raise the gap between being sick and being healthy and thus raises the marginal benefit of self-protection. Besides, when m rises, $u_1(w,h-m)$ falls if $u_{12}(w,h) > 0$, lowering the expected marginal utility of wealth and thus the marginal cost of self-protection. Therefore, the severity of the disease raise the willingness to pay for self-protection if $u_{12}(w,h) \geq 0$ (sufficient condition) and has an undetermined effect if $u_{12}(w,h) < 0$. Let us assume that $u_{12}(w,h) \geq 0$. To assess the effect of the uncertainty about the severity of the disease on the average willingness to pay for self-protection actions, we must determine whether W_p is convex or concave in m. We must thus determine the sign of $\frac{d^2W_p}{dm^2}$ defined as:

$$\frac{d^2W_p}{dm^2} = \frac{X'Y - XY'}{Y^2} \tag{9}$$

where:

$$
\begin{aligned}
X &= \Delta u_2(w,h-m)EU_1 + \Delta(p-\Delta)\left[u(w,h)-u(w,h-m)\right]u_{12}(w,h-m) > 0 \\
X' &= -\Delta u_{22}(w,h-m)EU_1 - \Delta(p-\Delta)(u(w,h)-u(w,h-m))u_{122}(w,h-m) \\
Y &= [EU_1]^2 > 0 \\
Y' &= -2EU_1(p-\Delta)u_{12}(w,h-m) < 0
\end{aligned}
$$

Note that $X > 0$ and $Y' < 0$ because $u_{12}(w,h) \geq 0$ has been assumed. From (9), we obtain that W_p is convex in m ($i.e.$ $\frac{d^2W_p}{dm^2} > 0$) if $u_{122}(w,h-m) \leq 0$ (sufficient condition). Note that the last assumption is a natural extension of $u_{12}(w,h) \geq 0$ since a more general behavioural – the preference for aggregating the harms – underlies both assumptions (see Eeckhoudt, Schlesinger and Rey (2007) and the explanation provided in Appendix A).

Under these two assumptions, we conclude that when individuals become more informed about the severity of the diseases, the average willingness to pay for self-protection actions should increase.

3 Average willingness to pay for self-insurance

Let us go back to the initial situation described at the beginning of Section 2 and suppose now that the severity of disease can be reduced (its probability remaining constant). The individual expected utility is again given by Eq. (1). The willingness to pay (denoted by W_m) for reductions Δ in the severity of disease is obtained from (10):

$$(1-p)u(w,h) + pu(w,h-m) = (1-p)u(w-W_m,h) + pu(w-W_m,h-m+\Delta) \tag{10}$$

W_m corresponds to the wealth variation which - when coupled with the reduction Δ (with $\Delta > 0$) in the severity of disease - leaves individuals at the constant expected utility $\overline{EU}$. The first order Taylor expansions of $u(w-W_m,h)$ and $u(w-W_m,h-m+\Delta)$ around $u(w,h)$ and $u(w,h-m+\Delta)$ respectively give:

$$u(w-W_m,h) \cong u(w,h) - W_m u_1(w,h) \tag{11}$$

$$u(w-W_m,h-m+\Delta) \cong u(w,h-m+\Delta) - W_m u_1(w,h-m+\Delta) \tag{12}$$

Inserting (11) and (12) into (10) and rearranging the terms, we obtain the folowing willingness to pay for a reduction Δ in the severity of the disease:

$$W_m \cong \frac{p\left[u(w,h-m+\Delta)-u(w,h-m)\right]}{\left[(1-p)u_1(w,h)+pu_1(w,h-m+\Delta)\right]} = \frac{pQ}{EU_1} \tag{13}$$

Eq. (13) indicates that the willingness to pay for lower severities of disease is the ratio of the marginal benefit of self-protection (enjoying $u(w,h-m+\Delta)$ instead of $u(w,h-m)$ in case of disease) to the expected marginal cost of a monetary unit spent (*i.e.* the marginal utility of wealth in the two states of the world in which the money is spent). To ease the notation, let us denote the denominator of (13) by EU_1 and $[u(w,h-m+\Delta)-u(w,h-m)]$ by Q.

3.1 Change in the baseline probability of disease

The way the willingness to pay for self-insurance changes with the baseline probability of disease is given by:

$$\frac{dW_m}{dp}=\frac{[u(w,h-m+\Delta)-u(w,h-m)]\,u_1(w,h)}{[EU_1]^2}=\frac{R}{S} \tag{14}$$

From (14) we notice that $u_1(w,h-m+\Delta)-u_1(w,h)\leq 0$ or $u_{12}(w,h)\geq 0$ is a sufficient condition to obtain an increase in the willingness to pay for self-insurance actions when the baseline probability of disease rises. As p increases, the usefulness of a self-insurance effort rises, increasing thus its marginal benefit. Besides, as indicated in Section 2.1, the marginal utility of a monetary unit spent falls with the baseline probability of disease as long as $u_{12}(w,h)>0$. This last condition is thus sufficient to obtain $\frac{dW_m}{dp}>0$. Let us now determine whether W_m rises at an increasing or at a decreasing rate with p. We must thus determine the sign of

$$\frac{d^2W_m}{dp^2}=\frac{R'S-RS'}{S^2} \tag{15}$$

where:

$$R=[u(w,h-m+\Delta)-u(w,h)]\,u_1(w,h)>0$$

$$R'=0$$

$$S={EU_1}^2>0$$

$$S'=\left({EU_1}^2\right)'=2EU_1\left[u_1(w,h-m+\Delta)-u_1(w,h)\right]<0$$

It turns out that:

$$\frac{d^2W_m}{dp^2}=\frac{2u_1(w,h)\,[u(w,h-m+\Delta)-u(w,h)]\,[u_1(w,h-m+\Delta)-u_1(w,h)]}{[EU_1]^3} \tag{16}$$

No matter how the willingness to pay changes with the baseline probability of disease (*i.e.* no matter the sign of (14)), we notice from (16) that changes occur at an increasing rate (resp. at a decreasing rate; resp. at a constant rate) if $u_{12}(w,h)>0$ (resp. if $u_{12}(w,h)<0$; resp. if $u_{12}(w,h)=0$). Therefore, the development of genetic testing should raise the average willingness to pay and thus increase the relevance of self-insurance programs if wealth and health are complementary ($u_{12}(w,h)>0$). The opposite conclusion is obtained if $u_{12}(w,h)<0$.

3.2 Effect of the severity of the disease

The way the willingness to pay for self-insurance changes with the severity of the disease is given by:

$$\frac{dW_m}{dm} = \frac{p\left[u_2(w,h-m) - u_2(w,h-m+\Delta)\right]EU_1 + p^2 Q u_{12}(w,h-m+\Delta)}{[EU_1]^2} = \frac{T}{V} \qquad (17)$$

Eq. (17) indicates that $u_{12} \geq 0$ is a sufficient condition to obtain an increase in the willingness to pay for self-insurance actions when the severity of the disease rises. We now define the conditions under which W_m rises at an increasing rate with m (assuming again $u_{12} \geq 0$).

$$\frac{d^2W_m}{dm^2} = \frac{T'V - TV'}{[EU_1]^4} \qquad (18)$$

where:

$$T > 0$$

$$T' = p\left[u_{22}(w,h-m+\Delta) - u_{22}(w,h-m)\right]EU_1 - p^2 Q u_{122}(w,h-m+\Delta)$$

$$V > 0$$

$$V' = -2pEU_1 u_{12}(w,h-m+\Delta) < 0$$

Note that $T > 0$ and $V' < 0$ because $u_{12} \geq 0$. Therefore $\frac{d^2W_m}{dm^2} > 0$ if $T' > 0$. This last condition is obtained when $u_{222} > 0$ and $u_{122} \leq 0$ (sufficient conditions). The first condition corresponds to the prudence towards health risks. The assumption has some empirical (see Dynan (1993) for instance) and experimental (see Deck and Schlesinger (2010)) support when financial risks are considered. It however remains to be shown that this trait of behavior holds when health risk are at stake. As explained in the previous section and shown in appendix A, $u_{122} \leq 0$ complements $u_{12} > 0$ since both assumptions correspond to a preference for aggregating the harms in the bivariate case.

When these conditions are met, the average willingness to pay for self-insurance actions is expected to rise as individuals become better informed about the severity of diseases.

4 Conclusion

The paper evaluates the way personalized information about the probability or about the severity of diseases modify the average willingness to pay for prevention actions. The conclusions we obtain in the different cases considered are quite diversified and mostly depend on the interaction between wealth and health in individuals' utility functions.

Specifically, we demonstrate the following results: 1) personalized information about the probability of disease raises the average willingness to pay for self-protection; 2) personalized information about the severity of disease raises the average willingness to pay for self-protection if wealth and health are complementary (or, equivalently, if individuals are correlation prone *i.e.* if $u_{12} \geq 0$, an assumption that has some empirical support in the literature) and if individuals are cross-imprudent in health (*i.e.* if $u_{122} \leq 0$, a natural extension of correlation loving); 3) personalized information about the probability of disease raises (resp. lowers; resp. does not modify) the average willingness to pay for self-insurance if individuals are correlation prone (resp. correlation averse; resp. correlation neutrals); 4)) personalized information about the severity of disease raises the average willingness to pay for self-insurance if individuals are correlation prone ($u_{12} \geq 0$), cross-imprudent in health ($u_{122} \leq 0$) and prudent in health ($u_{222} \geq 0$).

Our analysis indicates that changes in the average willigness to pay for prevention actions resulting from the acquisition of personal health information depend on the type of preventative activity considered (self-protection or self-insurance), on the type of information obtained (about the severity or about the probability of diseases) and on the interaction between wealth and health. However, given the empirical studies available yet and given some results recently highlighted in the risk theory literature, it is plausible to expect that personalized health information increases the average willingness to pay for prevention actions. In particluar, this implies that the future development of genetic testing should be accompanied by an expansion of health related prevention programs.

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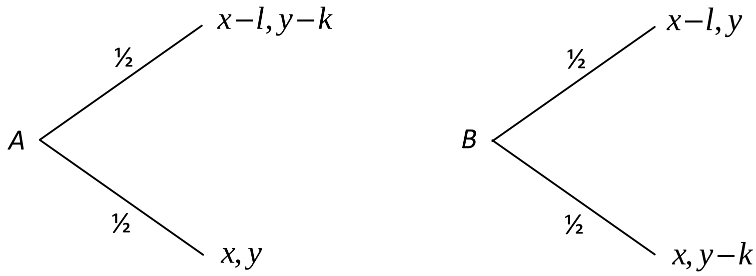
Appendix

A Correlation aversion and cross prudence

The connection between the concept of correlation aversion (first introduced by Richard (1975)) in risk theory and the complementarity between wealth and health can be made through the comparison of the following binary lotteries A and B:



In both lotteries, x and y are two attributes (x is wealth and y is health for example) subject to a potential loss (occurring with a probability of $\frac{1}{2}$) of l and k respectively. However, while these two losses are associated to the same state of the world (they are perfectly positively correlated) in lottery A, they are disaggregated (they are perfectly negatively[222] correlated) in lottery B. For an expected utiliy decision maker, the difference between A and B is given by:

$$\begin{aligned} R &= Eu(B) - Eu(A) \\ &= \frac{1}{2}[u(x-l, y-k) + u(x, y)] + \frac{1}{2}[u(x-l, y) + u(x, y-k)] \end{aligned}$$

Using second-order Taylor expansions, it can be shown that:

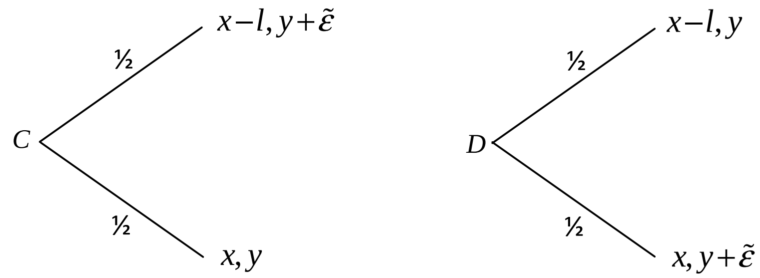
$$R = -\frac{lk}{2} u_{12}(x, y)$$

Therefore:

$$R \gtreqless 0 \iff u_{12}(x, y) \lesseqgtr 0$$

Correlation aversion (resp. correlation loving) corresponds in the expected utility model to $u_{12}(x, y) < 0$ (resp. $u_{12}(x, y) > 0$). In health economics, $u_{12}(x, y) > 0$ (*i.e.* correlation loving) refers to the complementarity between wealth and health. It expresses that an improved health state is better enjoyed when individuals are wealthier (or, equivalently, that a higher wealth is better exploited when individuals are healthier). Or, said differently, that individuals prefer the wealth and health losses to be aggregated. In the same way, correlation aversion indicates that wealth is better exploited when individuals are in deteriorated health states or that they prefer the wealth and health losses to be disaggregated.

Let us now show that this preference for the aggragation or the disaggragation of harms also determine whether individuals are cross-prudent or cross-imprudent in health. Consider the lotteries C and D:



Compared to lotteries A and B, the potential harm associated to health is not a sure wealth reduction of k but the a zero mean risk $\widetilde{\varepsilon}$ (that individuals dislike since they are averse to health risks; $u_{22}(w, h) < 0$). The parralel with the comparison of A and B is straightforward: the harms ($-l$ and $\widetilde{\varepsilon}$) are perfectly positively correlated in C and perfectly negatively correlated in D. For an expected utility decision maker, the difference between C and D is given by:

$$\begin{aligned} S &= Eu(D) - Eu(C) \\ &= \frac{1}{2}[u(x - l, y + \widetilde{\varepsilon}) + u(x, y)] + \frac{1}{2}[u(x - l, y) + u(x, y\widetilde{\varepsilon})] \end{aligned}$$

Using second-order Taylor expansions, it can be shown that:

$$S = \frac{1}{2} l \sigma_{\varepsilon}^2 u_{122}(x, y)$$

where σ_{ε}^2 denotes the variance of the zero mean risk $\widetilde{\varepsilon}$. Therefore:

$$S \gtreqless 0 \iff u_{122}(x, y) \gtreqless 0$$

Cross-prudence (resp. cross-imprudence) corresponds thus in the expected utility model to $u_{122}(x, y) > 0$ (resp. $u_{122}(x, y) < 0$). For individuals cross-prudent in health, an improved health state taking the form of the absence of the zero mean risk $\widetilde{\varepsilon}$ is better enjoyed when individuals are poorer (or, equivalently, that a higher wealth is better exploited when individuals do not face a health risk). As correlation prone individuals, they prefer the wealth and health harms to be aggregated in the same state of the world. In the same way, cross-imprudence indicates that wealth is better exploited when individuals face a health risk or that they prefer the wealth and health pains to be aggregated.

To wit, individual dissagregating the harms are correlation averse and cross-prudent in health respectively. Therefore, it is plausible to associate the assumptions $u_{12}(x, y) < 0$ and $u_{122}(x, y) > 0$ since they indicate a more general attitude towards risks. Using the same argument, it is plausible to jointly assume that $u_{12}(x, y) > 0$ and $u_{122}(x, y) < 0$.