Economics of Microinsurance[1]

Jimin Hong
College of Economics and Business Administration
Department of Finance and Insurance
Daegu University
201 Daegudaero, Jillyang, Gyeongsan, Gyeongbuk, 38453, Korea
jmhong@daegu.ac.kr

S. Hun Seog
Business School
Seoul National University
1 Gwanak Ro, Gwanak Gu, Seoul, 151-916, Korea
seogsh@snu.ac.kr

[1] Financial support from the Institute for Research in Finance and Economics of Seoul National University is gratefully acknowledged.

Economics of Microinsurance

Abstract: We propose a model of microinsurance focusing on health insurance. We consider the case in which utility is separable in wealth and health. We investigate when a consumer is determined to purchase insurance. Our first finding is that if wealth is low and the insurance product is bundled with different treatment costs, then a low take-up of insurance is possible. Second, the effect of risk exposure on insurance demand may be positive or negative. Third, the risk aversion effect is also ambiguous. Fourth, if the fixed cost is too high, then people do not participate in the insurance market. As the high fixed cost can be interpreted as a lack of trust and knowledge, this result confirms the existing empirical findings.

Economics of Microinsurance

I. Introduction

In general, microinsurance is defined as insurance with low premium and low (or limited) indemnity targeting low-income (or wealth) people (Churchill, 2006; Churchill and Matul, 2012).

Microinsurance began as a part of microfinance in the 1990s. Tomchinsky (2008) points out that microfinance institutions offered insurance to borrower and that was primarily credit life to pay off her loan if that borrower dies. According to the research conducted by International Labor Organization, the number of people insured by microinsurance has increased from 78 million in 2006 to 500 million in 2011. In 2010, Swiss Re estimated that the potential microinsurance market size is $40 billion, which covers up to 4 billon people; and in 2009, Lloyd's of London predicted that the market has the potential to provide up to 3 billion policies in 2014.

In this paper, we attempt to provide an economic model to answer the following question: "Why does microinsurance exist?" At first, the question may sound vacuous because microinsurance already exists. One may think that microinsurance exists to help low-income people who otherwise are not protected from health losses or property damages. Moreover, microinsurance is a type of regular insurance with low premium and low indemnity, the existence of which is well established in the literature (for example, Mossin, 1968). However, this line of thought seems unsatisfactory from the perspective of economic theory.

For this, note that the significance of microinsurance does not come simply from the fact that low-income people purchase insurance but from the fact that they now purchase insurance that they did not purchase before. To show the "meaningful" existence of microinsurance, we need to show *both* the non-existence of microinsurance before *and* its subsequent existence.

Judged from this viewpoint, the existence of microinsurance does not seem to be fully explained by the conventional economic theories such as that of Mossin (1968). Obviously, economic theories can show that a consumer may purchase no insurance or insurance with low premium and low coverage. However, it is not possible to explain why a consumer who purchased no insurance switches to purchase insurance, without incorporating additional factors.

The purpose of our analysis is to investigate the conditions under which a consumer opts to switch to purchasing insurance. We are concerned with the change in the contract design and costs that leads low-income people to purchase microinsurance. In contrast, the rich are less affected by such a change because they are less sensitive to it.

Our analysis also provides a theoretical framework for understanding the existence and roles of microinsurance as evidenced by empirical studies. For example, existing studies find that microinsurance is often not as welcome as expected and that microinsurance is more successful in some areas than in others. The theoretical framework can shed insights on the understanding of these differential responses across different societies. It also incorporates the institutional and cultural aspects, which help improve the understanding of the current state of microinsurance practice.

The remainder of the study is organized as follows. Section II reviews the existing literature and summarizes the findings of our analysis. Section III considers the benchmark model. Section IV presents the main model, and section V examines the effect of economic factors on the insurance demand. Section VI concludes.

II. Literature review and summary of results

It is well known that the poor are reluctant to purchase insurance even if they are risk averse. Matul et al. (2010) indicate that only about 2.6 percent of Africans (0.6 billion) buy insurance. One reason why the take-up rate of insurance is low may be the information problem. A number of studies point out that adverse selection and moral hazard are causes of low insurance purchasing behavior.

On the other hand, recent empirical studies have focused on other determinants of low demand of insurance. Among others, they include the liquidity constraint (caused by low income or wealth), lack of trust, and risk aversion.

Gollier (2003) explains that people under a liquidity constraint purchase more insurance and place higher value on insurance because of the lack of ability to deal with shocks and to smooth consumption. However, Cole et al. (2013) find that a liquidity constraint leads to a lower demand in rainfall insurance in India. On the other hand, Clarke (2011), Karlan et al. (2012), and Ito and Kono (2010) find that liquidity constraint has little effect on the take-up of microinsurance.

It seems that trust in insurance has a positive effect on insurance demand. Gineet al. (2008) find that in India the take-up rate of rainfall insurance decreases with basis risk, whereas the take-up rate increases with wealth and familiarity toward the insurance provider. Cole et al. (2013) suggest that a lack of trust leads to low insurance take-up as well. Cai et al. (2009) also claim that the lack of trust may be a barrier for individuals to enter the insurance market in China. Giesbert, Steiner, and Bendig (2011) also indicate that households do not fully understand microinsurance in Ghana; consequently, they are reluctant to purchase insurance. Basaza et al. (2008) find that a lack of trust in and inadequate information on community health insurance in Uganda results in the low insurance enrollment. Besides these studies, Dercon et al. (2011) point out that people are less likely to buy insurance because of the basis risk which refers to the risk when insurance payouts are not perfectly correlated with underlying losses.

On the other hand, standard economic theory implies that a more risk-averse individual purchases more insurance in general. In the case of microinsurance, however, most studies—barring that by Ito and Kono (2010)—find that more risk-averse people are less likely to purchase insurance (Gine et al., 2008; Cole et al., 2013; Giesbert, Steiner, and Bendig, 2011; Kouame and Komenam, 2012). Ito and Kono (2010) utilize the prospect theory and hyperbolic preference to explain the demand of health insurance in India. Since insurance covers loss, people behave risk-loving way and do not prefer the insurance in line with prospect theory. Ito and Kono (2010) also show that people with hyperbolic preference are more likely to buy insurance as a commitment device because they know that they have difficulty in saving. While the negative effect of risk aversion on insurance demand still seems to be a puzzle, Gine et al. (2008) suggest that people regard insurance as risky assets since they are uncertain regarding insurance.

Cole et al. (2013) find that if the price declines, then the take-up of insurance increases on the basis of the price elasticity of insurance and risk aversion has a negative effect on insurance demand. In addition, Giesbert, Steiner, and Bendig (2011) suggest that microinsurance is related to other financial services such as savings and loans. These services and insurance reinforce each other since insurance and other services are distributed by the same financial institutions. Thus, individuals can acquire information about insurance from them.

In addition to empirical studies, Liu and Myers (2014) set up a dynamic model with a liquidity constraint and insurer default risk. Because of the front-loaded feature of insurance, purchasing insurance may be costly under the liquidity constraint. They point out that reputation and trust are important to boost the insurance demand by showing that insurer default risk also lowers demand. Clarke (2011) also shows theoretically that the basis risk (the risk of non-performance) leads to a low insurance demand among risk-averse consumers.

Lastly, Eling et al. (2014) review the studies on microinsurance demand. They identify 12 characteristics that are associated with microinsurance demand from 51 papers: price, wealth, risk aversion, non-performance risk, trust and peer effects, religion, financial literacy, informal risk sharing, quality of service, risk exposure, age, and gender.

We propose a model of microinsurance focusing on health insurance. We consider the case in which utility is separable in wealth and health. Since people spend money on medical expense in case of a health shock, the utility from both money and health would decrease. However, we assume that the treatment affects health recovery and that the recovery restores the utility from health.[2] In addition, we investigate the effect of the bundled insurance for the separable treatment on the microinsurance demand. We also suppose that insurance premium is composed of fixed cost and actuarially fair premium. Fixed cost can be interpreted as a cost to build the relationship with trust and to educate people. It can be high distribution cost or diversification cost as well. Particularly, the risk may not be sufficiently diversified in the insurer's pool.

Our first finding is that if wealth is low and the insurance product is bundled with different treatment costs, then a low take-up of insurance is possible. If insurers offer insurance for each unbundled treatment, then a consumer purchases insurance for more essential treatment. However, this is not simply because she faces liquidity constraint. As wealth lowers, the consumer may choose to decrease medical expense when the consumer has no insurance, and it can be cheaper than the insurance premium. Second, the effect of risk exposure on insurance demand may be positive or negative. As the loss size increases, the medical expense increases as well. That is, the effect of loss size is positive on the insurance demand. However, as the probability of loss increases, the consumer may lower the medical expense, which implies that the effect of the probability is negative. Thus, the effect on the insurance demand in terms of premium may be either increased or decreased. Third, the risk aversion effect is also ambiguous. Fourth, if the fixed cost is too high, then the consumers do not participate in the insurance market. As the high fixed cost can be interpreted as a lack of trust and knowledge, this result is in line with the empirical findings. Finally, we show that the medical expense is higher with insurance than without it. However, note that the increase in expense does not come from moral hazard in our model, because there is no information asymmetry. This effect reflects the utility change due to insurance in determining the optimal medical expense.

---

[2] This approach is in line with Cook and Graham (1977), who stated that loss on irreplaceable goods such as health may lower the policyholder's utility more in addition to monetary loss. Shioshansi (1982), Schlesinger (1984), and Hong and Seog (2014) also argue that the utility may change when loss occurs on irreplaceable goods, so the state-dependent utility approach is useful to explain optimal insurance for irreplaceable goods. We also regard health as an irreplaceable good and the utility is therefore changed additionally by health recovery besides the change in utility from money.

III. The benchmark model

We consider a simple one-period model in which a consumer faces random health loss. As noted above, we divide the utility into two parts. The utility regarding health is denoted by $V(.)$, and the utility regarding money (consumption) is presented as $U(.)$. The endowment of health is presented by S, and the utility when the consumer is healthy is $V(S)$. Since each utility function is strictly concave and without loss of generality, we suppose that $V(S)=0$. In addition, $U'(0)=\infty$. The consumer suffers from health loss D with probability p and spends x of medical expense for the treatment with respect to D. Given the medical expense x, the health level is improved by $H(x)$. Hence, the utility related to health becomes $V(S-D+H(x))$. We assume $H'(x)>0$ and $H''(x)\le 0$. $V(S-D+H(x))$ is negative when $D>H(x)$.

Insurance contract is based on the medical expense x and coinsurance. The consumer purchases health insurance with indemnity given by ax, where $0<a\le 1$. We suppose that insurance premium is fair. Insurance premium Q is denoted as $Q=apx$. Wealth of consumers is y. We also suppose that there is no information asymmetry problem.

We first examine the utility of the consumer without insurance. Without insurance, the consumer only chooses optimal medical expense to maximize her utility following program 1.

[Program 1: No insurance, one-type expense]

$$\underset{x}{Max}\ Eu_n=(1-p)U(y)+p[U(y-x)+V(S-D+H(x))] \quad (1)$$

In (1), the first term is the utility without loss and the second term is the utility with loss when the medical expense is x. Then, the first-order condition for the above problem is expressed as

$$U'(y-x)=V'(S-D+H(x))H'(x) \quad (2)$$

Condition (2) shows that the optimal medical expense is determined at the point where the marginal benefit of medical expense equals the marginal cost of medical expense.

Further, when the consumer purchases an insurance contract, she decides both the insurance coverage and the medical expense to maximize her (expected) utility. The problem is as follows:

[Program 2: Insurance, one-type expense]

$$\begin{aligned}\underset{x,a}{Max}\ Eu_b&=(1-p)[U(y-apx)+V(S)]+p[U(y-apx-x+ax)+V(S-D+H(x)] \quad (3)\\&=(1-p)U(y-apx)+p[U(y-apx-x+ax)+V(S-D+H(x)]\end{aligned}$$

Let us denote that $U(y-apx)=U_{00}$, $U(y-apx-x+ax)=U_{01}$, $V(S-D+H(x))=V$ and $H(x)=H$ for simplicity. Then, the first-order conditions are

$$L_x = (1-p)(-ap)U_{00}' + p(-ap-1+a)U_{01}' + pV'H' = 0 \quad (4)$$
$$L_a = (1-p)(-px)U_{00}' + p(-px+x)U_{01}' = (1-p)x[-p(U_{00}' - U_{01}')] \quad (5)$$

From (5), we observe that $L_{a|a=0} > 0$ and $L_{a|a=1} \geq 0$. That is, purchasing full insurance is optimal even though wealth is low. In addition, the medical expense is satisfied by the following condition:

$$U'(y-px) = V'(S-D+H(x))H'(x) \quad (6)$$

The meaning of (6) is similar to (2). By comparing the expression (2) and (6), we obtain lemma 1.

Lemma 1. We have the following results:
(1) Full insurance is optimal.
(2) The medical expense is higher with insurance than without it.
(3) As wealth increases, consumers spend more medical expense in both insurance and no insurance cases.

Proof. See the appendix. //

It is evident that the consumer can spend more medical expense when she purchases insurance. The utility is also higher with the insurance than without it by concavity of utility function U and higher medical expense. In addition, we interpret higher expense x as the purchase of more insurance in terms of insurance premium. That is, consumers will buy more insurance as wealth increases.

In this model, the consumer chooses the medical expense following full insurance. While the model is slightly different from the standard model (like that in Mossin, 1968), it has qualitatively the same intuition that the consumer purchases full insurance under actuarially fair premium. The standard model can explain the fact that the consumer purchases insurance, but it has difficulty in explaining the "meaningful" existence of microinsurance without considering additional factors.[3] That is, it cannot explain why those who do not purchase insurance opt to purchase insurance. In the following section, we propose a model for the existence of microinsurance.

IV. The Model

Let us first show that a consumer may prefer to purchase no insurance under actuarially fair premium. Next, we show how she switches to purchasing insurance.

We suppose that the medical expense x is divided into two separate medical expenses, x_1 and x_2, for the first and second treatment, respectively. The health recovery $H(x)$ is also divided into $H_1(x_1)$ and $H_2(x_2 - l)$ for both treatments, where $H_1(0) = 0$ and

[3] When the premium is actuarially unfavorable, the consumer may purchase partial coverage. However, it still cannot explain why the consumer switches to purchasing insurance when microinsurance is provided.

$H_2(x_2 - l) = 0$ if $x_2 \le l$. The second treatment requires more medical expense than l to have an effect. Both H_1 and H_2 are concave and twice differentiable, similar to $H(x)$. However, $H_1'(z) < H_2'(z)$ for $z \ge l$.

Now, we first examine the case without insurance as the benchmark case. If the consumer does not buy insurance, then she can choose x_1 and x_2 separately depending on her wealth. The utility without insurance is denoted as Eu_0. The maximization problem is as follows:

[Program 3: No insurance, two-type expenses]

$$\underset{x_1^N,\, x_2^N}{Max}\ Eu_0 = (1-p)U(y) + pU(y - X_N) + pV(S - D + H_1(x_1^N) + H_2(x_2^N - l))$$

$$X_N = x_1^N + x_2^N \qquad (7)$$

Therefore, the optimal health expense is determined by the following condition:

$$U'(y - X_N) = V'(S - D + H_1(x_1^N) + H_2(x_2^N - l))H_1'(x_1^N) \qquad (8)$$
$$U'(y - X_N) = V'(S - D + H_1(x_1^N) + H_2(x_2^N - l))H_2'(x_2^N - l) \qquad (9)$$

As wealth is low, the consumer is less likely to spend money on medical expenses. This is because the marginal benefit from money (marginal cost of medical expense) is higher than the benefit from health. Further, when $V'(S - D + H_1(x_1^N) + H_2(x_2^N - l))$, $H_1'(x_1^N)$, and $H_2'(x_2^N - l)$ are high, which implies that the benefit from health and the effect of the treatment are significantly high, the consumer spends more money on medical expenses.

We denote the medical expense level satisfying $H_2(K_1 - l) = H_1(K_1)$ as K_1. In addition, we assume that $\lim_{\varepsilon \to 0} H_1'(\varepsilon) < H_2'(K_1 - l)$. We also define the minimum health expense level as K_2, which satisfies $\lim_{\varepsilon \to 0} H_1'(\varepsilon) = H_2'(K_2 - l - \varepsilon)$. Note that first, if the consumer can spend less than K_1 on medical expense, then she only spends money on the first treatment for H_1. Second, if the total medical expense is in between K_1 and K_2, then she spends money only for H_2. Lastly, if the total medical expense is higher than K_2, then she allocates money for both H_1 and H_2.

Further, we assume the existence of the insurance that is bundled with x_1 and x_2. That is, the consumer cannot buy the insurance for each x_i individually. We also assume that the insurance premium of bundled product is based on x_1, where $x_2 = bx_1$ and $b > 0$. The coverage and the premium are denoted as the function of x_1. Then, the problem is rewritten as

[Program 4: Insurance, bundled expenses]

$$\underset{x_1, a}{Max} Eu_1 = (1-p)U(y - ap(1+b)x_1) + pU(y - ap(1+b)x_1 - (1+b)x_1 + a(1+b)x_1)$$
$$+ pV(S - D + H_1(x_1) + H_2(bx_1 - l)) \quad (10)$$

We denote that $U(y-ap(1+b)x_1) = U_0, U(y-ap(1+b)x_1 - (1+b)x_1 + a(1+b)x_1) = U_1$, $V(S - D + H_1(x_1) + H_2(bx_1 - l)) = V$, $H_1(x_1) = H_1$, and $H_2(bx_1 - l) = H_2$. The first-order conditions are as below:

$$L_{x_1} = (1-p)(-ap(1+b))U_0' + p(-ap-1+a)(1+b)U_1' + pV'H_1' = 0 \quad (11\text{ a})$$
$$L_{x_1} = (1-p)(-ap(1+b))U_0' + p(-ap-1+a)(1+b)U_1' + pV'(H_1' + bH_2') = 0 \quad (11\text{ b})$$
$$L_a = (1-p)(-p(1+b)x_1)(-U_0' + U_1') = 0 \quad (12)$$

We obtain that $L_{a|a=0} > 0$ as follows:

$$L_{a|a=0} = (1-p)(-p(1+b)x_1)U'(y) + p(1-p)(1+b)x_1U'(y-(1+b)x_1)$$
$$= (1-p)(1+b)(x_1)[-pU'(y) + pU'(y-(1+b)x_1)] > 0 \quad (13)$$

We also observe that $L_{a|a=1} \geq 0$ from (12). Now, we have following condition for optimal coverage and medical expense by rearranging the above expressions (11) and (12):

$$(1+b)U'(y - p(1+b)x_1) = V'(S - D + H_1(x_1))H_1' \text{ }, bx_1 \leq l \quad (14\text{ a})$$
$$(1+b)U'(y - p(1+b)x_1) = V'(S - D + H_1(x_1) + H_2(bx_1 - l))(H_1' + bH_2') \text{ }, bx_1 > l \quad (14\text{ b})$$

From the expressions (8), (9), (14a), and (14b), we obtain following results. Technically, the medical expense x_i^N without insurance, where $i = 1, 2$, is determined such that each marginal benefit of treatment $V'(S - D + H_1(x_1^N) + H_2(x_2^N - l))H_1'(x_1^N)$ and $V'(S - D + H_1(x_1^N) + H_2(x_2^N - l))H_2'(x_2^N - l)$ equals marginal cost $U'(y - x_1^N - x_2^N)$.

Similar to the case without insurance, the consumer determines each medical expense level at which the marginal benefit of treatment equals the marginal cost of treatment as well. However, the benefit and cost only depend on the level of x_1.

Let us define $(1-p)U(y) + pU(y - x_1^N) = U(y - px_1^N - r.p_1)$, where r.p represents a risk premium at x_1^N, $\Delta U_1 = U(y - p(1+b)x_1) - (1-p)U(y) - pU(y - x_1^N)$,
$\Delta U_2 = U(y - p(1+b)x_1) - (1-p)U(y) - pU(y - x_2^N)$,
$\Delta V_1 = V(S - D + H_1(x_1)) - V(S - D + H_1(x_1^N))$,
$\Delta V_2 = V(S - D + H_1(x_1) + H_2(bx_1 - l)) - V(S - D + H_1(x_1^N))$,
$\Delta V_3 = V(S - D + H_1(x_1)) - V(S - D + H_2(x_2^N - l))$ and
$\Delta V_4 = V(S - D + H_1(x_1) + H_2(bx_1 - l)) - V(S - D + H_2(x_2^N - l))$.

Now, we suppose that $p(1+b) \geq 1$. We impose the constraint on wealth to depict the case with low wealth. At first, if $y \leq K_1 + U'^{-1}(V'(S - D + H_1(K_1))H_1'(K_1))$. Under this constraint, the consumer without insurance only spends the money as the first medical expense. In addition, if $y \le p(1+b)\frac{l}{b} + U'^{-1}(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b})$, then $bx_1 \le l$ and consequently $H_2(bx_1 - l) = 0$, given D. Thus, if

$$y \le \min\left\{ K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)),\ p(1+b)\frac{l}{b} + U'^{-1}(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}) \right\},$$

then the medical expense for the first treatment with insurance is less than the expense without insurance. That is, $x_1 < x_1^N$. In this case, if $p(1+b)x_1 > px_1^N - r.p$, then the consumer does not purchase insurance since the indirect utility without insurance is greater than the utility with insurance. Even if $p(1+b)x_1 < px_1^N - r.p$, the consumer may not buy insurance as long as $\Delta U_1 < -p\Delta V_1$. That is, the consumer can spend more medical expense without insurance and the increase in utility from health recovery may be greater than the decrease in utility from money.

Second, if

$$p(1+b)\frac{l}{b} + U'^{-1}(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}) < y \le K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)),$$ then

the consumer may not buy insurance when $\Delta U_1 < -p\Delta V_2$. In this case, the consumer with insurance allocates money for both treatments and the second treatment is effective, whereas the consumer without insurance only spends for the first treatment. At this time, if the total effect of both treatments is less effective than focusing on the first treatment, the consumer may still not be covered.

Third, let us suppose that $K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)) < y \le K_2 + U'^{-1}(V'(S-D+H_1(K_2))H_1'(K_2))$. Then, the consumer without insurance only spends her money for the second treatment. As a result, if

$$K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)) < y$$
$$\le \min\left\{ K_2 + U'^{-1}(V'(S-D+H_1(K_2))H_1'(K_2)),\ p(1+b)\frac{l}{b} + U'^{-1}(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}) \right\},$$

then the second treatment is effective for the consumer with insurance. However, if $\Delta U_2 < -pV_3$, the consumer does not buy insurance.

Lastly, similar to the first case, if

$$\max\left\{ p(1+b)\frac{l}{b} + U'^{-1}(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}),\ K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)) \right\} < y$$

$\le K_2 + U'^{-1}(V'(S-D+H_1(K_2))H_1'(K_2))$ and $\Delta U_2 < -pV_4$, then, again, the consumer does not buy insurance. This observation is summarized in the following proposition 1.

Proposition 1. Suppose that $p(1+b)\geq 1$. A consumer does not purchase insurance when the following conditions hold.

(1) If

$$y \leq \min\left\{ K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)),\ p(1+b)\frac{l}{b} + U'^{-1}\left(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}\right) \right\}$$

, the consumer does not purchase insurance when $p(1+b)x_1 > px_1^N + r.p$. Even if $p(1+b)x_1 < px_1^N + r.p$, the consumer may not buy insurance when $\Delta U_1 < -p\Delta V_1$.

(2) If

$$p(1+b)\frac{l}{b} + U'^{-1}\left(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}\right) < y \leq K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1))$$

and $\Delta U_1 < -p\Delta V_2$, the consumer does not purchase insurance.

(3) If $K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)) < y$

$$\leq \min\left\{ K_2 + U'^{-1}(V'(S-D+H_1(K_2))H_1'(K_2)),\ p(1+b)\frac{l}{b} + U'^{-1}\left(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}\right) \right\}$$

and $\Delta U_2 < -pV_3$, the consumer does not purchase insurance.

(4) If

$$\max\left\{ p(1+b)\frac{l}{b} + U'^{-1}\left(\frac{V'(S-D+H_1(\frac{l}{b}))H_1'(\frac{l}{b})}{1+b}\right), K_1 + U'^{-1}(V'(S-D+H_1(K_1))H_1'(K_1)) \right\} < y$$

$\leq K_2 + U'^{-1}(V'(S-D+H_1(K_2))H_1'(K_2))$ and $\Delta U < -p\Delta V_1$, the consumer does not purchase insurance.

Proof. See the text above. //

Proposition 1 shows that there exist the cases in which the utility is higher without insurance than with it. At first, if the consumer purchases insurance, then her treatment cost may be less than the cost without insurance on H_1 since she has to allocate the money for H_2 and pay premium for the bundled insurance with H_1 and H_2 even though the treatment for H_2 is not effective. That is, if the insurance product contains less essential, more expensive, and highly time-consuming treatment costs and the consumer cannot buy the insurance for the respective treatments, then she decides not to buy insurance. This may be one explanation why poor people do not buy insurance despite of fair premium. These observations indicate that the microinsurance should have a form that covers that treatment is necessary and immediate for the poor.

Furthermore, in the medium range of wealth such as the cases (3) and (4) in proposition

1, a consumer without insurance can put their money into the more effective treatment for H_2, whereas a consumer with insurance can still allocate some money to the less effective treatment for H_1. These cases can also explain the demand of regular insurance as well as that of microinsurance. Some people do not want to purchase insurance for weak and mild illnesses, instead seeking cheap treatment; in contrast, they want to purchase insurance for fatal illnesses requiring expensive treatment. Given the observation above, this study focuses on the case (1) in proposition 1 to discuss the demand of individuals with low wealth.

Meanwhile, if the insurers provide the insurance for each expense x_1 and x_2 separately, then the consumer's problem becomes

[Program 5: Insurance, separated expenses]

$$\max_{x_1^1, x_2^1, a_1, a_2} Eu_2 = (1-p)U(y - a_1 p x_1^S - a_2 p x_2^S) + pU(y - a_1 p x_1^S - a_2 p x_2^S - x_1^S - x_2^S + a_1 x_1^S + a_2 x_2^S)$$
$$+ pV(S - D + H_1(x_1^S) + H_2(x_2^S - l)) \quad (16)$$

Let us denote that $U(y - a_1 p x_1^S - a_2 p x_2^S) = U_0^S$, $U(y - a_1 p x_1^S - a_2 p x_2^S - x_1^S - x_2^S + a_1 x_1^S + a_2 x_2^S) = U_1^S$, $V(S - D + H_1(x_1^S) + H_2(x_2^S - l)) = V^S$, $H_1(x_1) = H_1$ and $H_2(x_2 - l) = H_2$. From program 5, we obtain the following:

$$L_{x_1} = (1-p)(-a_1 p)U_0^S{}' + p(-a_1 p - 1 + a_1)U_1^S{}' + pV^S{}' H_1{}' = 0 \quad (17)$$
$$L_{x_2} = (1-p)(-a_2 p)U_0^S{}' + p(-a_2 p - 1 + a_2)U_1^S{}' + pV^S{}' H_2{}' = 0 \quad (18)$$
$$L_{a_1} = (1-p)(-p x_1^1)U_0^S{}' + p(-p x_1^1 + x_1^1)U_1^S{}' \geq 0 \quad (19)$$
$$L_{a_2} = (1-p)(-p x_2^1)U_0^S{}' + p(-p x_2^1 + x_2^1)U_1^S{}' \geq 0 \quad (20)$$

We obtain the following ordered pairs of coverage (1, 0), (0, 1), and (1, 1), which are denoted as (a_1, a_2) depending on the wealth level. We also have following condition from above first-order conditions. The optimal medical expenses and coverage satisfy the following condition:

$$U_1^S{}' = V_S{}' H_1{}' \quad (21a)$$
$$U_1^S{}' = V_S{}' H_2{}' \quad (21b)$$

We now provide a detailed analysis. At first, if $y \leq pK_1 + U'^{-1}(V'(S - D + H_1(K_1))H'_1(K_1))$, then the optimal coverage is (1, 0). Next, if $y \leq pK_2 + U'^{-1}(V(S - D + H_2(K_2 - l))H_2{}'(K_2 - l)$, then the consumer selects (0, 1) for the coverage. Finally, if $y > pK_2 + U'^{-1}(V(S - D + H_2(K_2 - l))H_2{}'(K_2 - l)$, then they choose (1, 1).

Intuitively, the consumer utility with separated insurance is greater than that with bundled insurance since bundled insurance imposes additional constraints ($x_2 = bx_1$) on the consumer.

Therefore, the utility increases when the insurance is provided separately for each treatment. In addition, the utility with separated insurance is always greater than that without insurance. If the insurance compensates the individual medical expenses separately, the low income will be able to purchase only the insurance for the treatment that is inexpensive and has an immediate effect, thereby improving the welfare. As a result, we obtain the following proposition.

Proposition 2. If the coverage for medical expense x_1 and for x_2 are provided separately, then a consumer who does not purchase insurance in proposition 1 purchases insurance.

Proof. See the text above.//

V. Effects of factors on microinsurance demand

In this section, we investigate the effect of risk exposure, risk aversion, and fixed cost on the microinsurance demand. We concentrate on the case of (1) in proposition 1 to limit the scope of the later discussion to low wealth case.

5.1.Effect of risk exposure

The existing empirical studies regard the experience of past shocks as risk exposure. In addition, the age of the insured is considered as the variable that denotes the likelihood of exposure to (health) risk. In this study, both the size of D and the probability p are regarded as the proxy variables to present the risk exposure since we treat a one-period model. If the loss size and the probability tend to be steady and stable, then the proxy may be natural.

From expression (14 a), we have proposition 3.

Proposition 3. The risk exposure effect on medical expense is as follows:

(1) A consumer spends more medical expense as the loss size increases.
(2) A consumer spends less medical expense as the risk probability increases. As a result, the effect of the risk exposure on the insurance demand is ambiguous.

Proof. See the appendix. //

Proposition 3 indicates the mixed result on the relation between insurance demand and risk exposure in the same manner as the existing empirical studies do. Giesbert, Steiner, and Bendig (2011) point out that the households with higher subjective belief of risk than others are less likely to buy insurance, whereas Akter et al. (2008) find the reverse relation.If the risk probability increases, a consumer spends less medical expense to lower the insurance premium. As a result, the sign of insurance premium change is ambiguous following the negative relation between the risk probability and medical expense. In addition, we obtain the same result in case of separated insurance. That is, the effect of risk exposure on the general demand of health insurance may be not clear.

5.2. Effect of risk aversion

It is still controversy how risk aversion affects insurance demand. In the microinsurance literature, as well as in general insurance literature, the impact of risk aversion on insurance demand remains unclear. Although some studies claim that the effect of risk aversion is negative on the demand, the effect is still ambiguous. To examine the effect of risk aversion, we consider a model with loading factor $\lambda, \lambda > 0$. That is, the premium is actuarially unfavorable.

[Program 6: Bundled Insurance, actuarially unfavorable premium]

$$\underset{x,a}{Max} \quad Eu_{\lambda} = (1-p)[U(y-(1+\lambda)ap(1+b)x_1)]$$
$$+p[U(y-(1+\lambda)ap(1+b)x_1-(1+b)x_1+a(1+b)x_1)+V(S-D+H(x_1)] \quad (22)$$

Let us also denote that $U(y-(1+\lambda)apx_1) = U_{\lambda 0}$, $U(y-(1+\lambda)ap(1+b)x_1-(1+b)x_1+a(1+b)x_1) = U_{\lambda 1}$,and $V(S-D+H(x_1)) = V$ for simplicity. The first-order conditions are

$$L_{x_1} = (1-p)(-(1+\lambda)ap(1+b))U_{\lambda 0}' + p(-(1+\lambda)ap(1+b)-(1+b)+a(1+b))U_{\lambda 1}' + pV'H' = 0$$
(23)
$$L_a = (1-p)(-(1+\lambda)p(1+b)x_1)U_{\lambda 0}' + p(-(1+\lambda)p(1+b)x_1+(1+b)x_1)U_{\lambda 1}'$$
$$= [1-(1+\lambda)p](1+b)px_1(U_{\lambda 1}'-U_{\lambda 0}') - \lambda p(1+b)x_1U_{\lambda 0}' \quad (24)$$

Both cases that have $L_{a|a=0} \geq 0$ and $L_{a|a=0} < 0$ are possible, depending on the loading size. If loading λ is too high, then policyholders do not buy insurance. This indicates that the effect of price on the insurance demand is negative. It is also that $L_{a|a=1} = [1-(1+\lambda)p]p(1+b)x_1[U'(y-x_1)-U'(y)] - \lambda p(1+b)x_1U'(y) < 0$. If optimal a is within $0 < a \leq 1$, we have following condition and lemma 2:

$$U'(y-(1+\lambda)ap(1+b)x_1-(1+b)x_1+a(1+b)x_1) = V'(S-D+H(x_1))H'(x_1) \quad (25)$$

Lemma 2. Suppose that loading is positive. Then, we have the following results.
(1) Partial insurance is optimal.
(2) The medical expense with insurance is higher than the expense without insurance when wealth is sufficient high.
(3) As wealth increases, consumers spend more medical expense in both insurance case and no insurance case.

Proof. The proof is similar to that of lemma 1, so it is omitted here. //

Now, let us suppose that there exist two consumers with ARA_H and ARA_L, where $ARA_H(y) > ARA_L(y)$, and the utilities of consumer are denoted as U_H and U_L. Then, we denote U_H as $f(U_L)$, where f is an increasing concave function. We assume that V and H are the same regardless of risk aversion. From expressions (24) and (25), we have the following proposition 4.

Proposition 4. We have the following results:

(1) Suppose that the insurance premium is actuarially unfavorable. Then, the effect of risk aversion on insurance demand is not clear.

(2) Suppose that the insurance premium is actuarially fair. Then, a more risk-averse consumer spends less medical expense when condition (26) holds.

$$f'(U_L(y-p(1+b)x_{1L}))>1 \quad (26)$$

where x_{1L} is the optimal medical expense of a less risk-averse consumer.

Proof. See the appendix.//

Unlike Mossin's study, proposition 4 states that more risk-averse consumer is less or more likely to buy insurance. In this setting, a consumer chooses not only coverage but also medical expense, so the effect of risk aversion on both coverage and medical expense is mixed. If the medical expense of a less risk-averse consumer is greater than the expense of a more risk-averse one, then the coverage of the former one is greater than the latter one. However, in the opposite case, the size of the relative coverage is ambiguous.

Further, if the premium is actuarially fair, then both more risk-averse and less risk-averse consumers purchase full insurance. In this case, a more risk-averse consumer selects less medical expense when condition (26) holds. That is, the insurance demand in terms of insurance premium decreases. Proposition 4 can explain the result of empirical studies that the risk aversion is negatively related to insurance demand or the effect of risk aversion on insurance demand is not clear.

5.3.Effect of fixed cost

Now, we suppose that the insurance premium is composed of the net premium and fixed cost.[4] As noted above, fixed cost is regarded as the cost for building a long-term relationship with the consumer or building trust and positive brand image. Then, insurance premium Q is denoted as $Q=F+ap(1+b)x_1$. The following problem is:

[Program 7: Insurance, bundled insurance with fixed cost]

$$\underset{x,a}{Max}\; Eu_3=(1-p)U(y-(F+ap(1+b)x_1))$$
$$+p[U(y-(F+ap(1+b)x_1)-(1+b)x_1+a(1+b)x_1)+V(S-D+H(x_1))] \quad (27)$$

We denote that $U(y-(F+ap(1+b)x_1))=U_0^F$, $V(S-D+H(x_1))=V$, $H(x_1)=H$ and $U(y-(F+ap(1+b)x_1)-(1+b)x_1-a(1+b)x_1)=U_1^F$. Then, the first-order conditions are

$$L_a=-(1-p)p(1+b)x_1U_0^F{}'+p[-p(1+b)x_1+(1+b)x_1]U_1^F{}'=0 \quad (28)$$
$$L_{x_1}=-(1-p)ap(1+b)U_0^F{}'+p[(-ap(1+b)-(1+b)+a(1+b))U_1^F{}'+V'H']=0 \quad (29)$$

[4] For simplicity, we suppose that the variable cost equals to zero in the later discussion.

Rearranging these conditions, we have

$$U_0^F{}' = U_1^F{}' \quad (30)$$
$$U_1^F{}' = V'H' \quad (31)$$

Condition (31) is similar in meaning to (7). Medical expense depends on the relative size of marginal utility of both money and health. If wealth is high and the utility from health is important, then the expense would be high. Now, let us denote the medical expense level as x^0 determined in (1) (without insurance) and x^1 determined in (31) (with insurance and fixed cost). Then, we have the following properties.

Proposition 5.

(1) If there exists a fixed cost, full insurance is optimal.

(2) Medical expense is higher with insurance than without it when $F + px^0 < x^0$.

Proof. See the appendix.//

Proposition 5 (1) indicates the typical results of insurance demand as Mossin (1968) points out. Since fixed cost does not affect marginal benefit of insurance, full insurance is optimal without variable cost.

Proposition 5 (2) states the condition for $x^1 > x^0$. Note that $x^1 > x^0$ does not imply the moral hazard problem. As noted above, we assume that the asymmetric information problem does not exist. Under this condition, a consumer purchases insurance since the utility from health increases compared with the utility without insurance. In other words, if the fixed cost is sufficiently low, then individuals with insurance can smooth utilities between healthy and sick states by spending more medical expense.

The indirect utility with insurance at x^1 is expressed as

$$\begin{aligned} Eu_3(x^1) &= (1-p)U(y-F-p(1+b)x^1) + p[U(y-F-p(1+b)x^1) + V(S-D+H(x^1))] \\ &= U(y-F-p(1+b)x^1) + pV(S-D+H(x^1)) \qquad (32) \end{aligned}$$

Let us compare the indirect utility with the utility without insurance. We obtain following results.

Proposition 6. The utility with insurance is higher than the utility without insurance at each optimal treatment level if $F + px^1 \le px^0 + risk\ \ premium$ or if not, when the difference between utilities from health is large enough. Otherwise, individuals do not purchase insurance.

Proof. See the appendix.//

In proposition 6, we know that if the fixed cost is too high, then the consumer may not buy insurance. At first, the fixed cost can be interpreted as cost for building trust. Basaza et al. (2008) and Dercon et al. (2011) point out that the lack of trust can be one reason for low insurance adoption in health insurance. Secondly, the fixed cost represents the cost that arises from the lack of financial literacy. The poor are less likely to have the opportunity to acquire financial information and education. Therefore, they may not fully understand the insurance and, in turn, may not trust the insurance as well. Another potential explanation for high fixed cost can be the inefficient way for advertising and marketing because of undeveloped mass media in some countries. Lastly, fixed cost can be regarded as the transaction cost. Aizer (2007), Baicker et al. (2012), and Bansak and Raphael (2007) claim that the burden of transaction cost induces low insurance demand in the U.S.

We consider the case that $Eu_3(x^1) > Eu_n(x^0)$ to discuss the purchasing insurance case that is normally meaningful. Let us consider the subcase that $x^0 > F + px^1$. In addition, we assume that $F + px^0 \le px^0 + R.P$, where $R.P$ indicates risk premium. That is, individuals buy insurance and $Eu_3(x^1) > Eu_n(x^0)$ at x^0. Let us denote that $F^0 = R.P(x^0)$ and consider both Eu_n and Eu_3 as a function of x. Then, this case corresponds to $F \le F^0$ and is depicted in Figure 1.

Figure 1 around here.

On the other hand, if we assume that $F > F^0$, then $Eu_3(x^0) < Eu_n(x^0)$. This subcase is described in Figure 2.

Figure 2 around here.

The above two cases show that people buy insurance and spend x^1 as medical expense, but the expected utility with insurance at x^0 may or may not be higher than the utility without insurance depending on the size of fixed cost.

Meanwhile, let us define the level of medical expense x^F, satisfying the following:

$$Eu_3(x^F) = Eu_n(x^0)$$
$$\Leftrightarrow U(y - F - px^F) + pV(S - D + H(x^F)) = pU(y - x^0) + pV(S - D + H(x^0) + (1-p)U(y) \quad (33)$$

We already know that $x^F < x^1$, since $Eu_3(x^1) > Eu_n(x^0)$. In addition, we observe that $x^F < x^0$ if $F < F^0$ from figure 1. This result shows that if the fixed cost is low, then individuals can obtain the same utility from lower medical expense.

VI. Conclusion

The purpose of our analysis is to investigate under what conditions a consumer opts to switch to purchasing insurance. We are concerned with the change in the contract design and costs that leads low-wealth people to purchase microinsurance. We propose a model of microinsurance focusing on health insurance and consider the case in which utility is separable in wealth and health.

Our first finding is that if wealth is low and insurance is bundled in the sense that the insurance covers diverse treatment costs, then a low take-up of insurance is observable. The reason why people do not purchase insurance is not simply because they face liquidity constraint. As wealth decreases, people may choose to lower treatment cost when they have no insurance, and this can be cheaper than insurance premium. If insurers offer unbundled insurance, then people who do not want to buy bundled insurance may buy unbundled insurance for more essential treatments. Second, the effect of risk exposure on insurance demand may be positive or negative. As the loss size increases, the treatment cost increases as well. That is, the effect of loss size is positive on the insurance demand. However, as the probability of loss increases, people may lower the treatment cost, which implies that the effect of the probability is negative. Thus, the effect on the insurance demand in terms of premium may either increase or decrease. Third, the risk aversion effect is also ambiguous. Fourth, if the fixed cost is too high, then people do not participate in the insurance market. As a high fixed cost can be interpreted as a lack of trust and knowledge, this result confirms the existing empirical findings.

References

Akter, Sonia, et al. "Determinants of participation in a catastrophe insurance programme: Empirical evidence from a developing country." *2008 Conference (52nd), February 5-8, 2008, Canberra, Australia*. No. 5984. Australian Agricultural and Resource Economics Society, 2008.

Basaza, Robert, Bart Criel, and Patrick Van der Stuyft (2008), "Community health insurance in Uganda: why does enrolment remain low? A view from beneath." *Health Policy* 87.2 : 172-184.

Cai, Hongbin, et al (2009), "Microinsurance, trust and economic development: Evidence from a randomized natural field experiment". No. w15396. *National Bureau of Economic Research*.

Churchill, Craig (eds.) (2006), *Protecting the Poor: A Microinsurance Compendium*, International Labour Office.

Churchill, Craig and Michal Matul (eds.) (2012), *Protecting the Poor: A Microinsurance Compendium Volume II*, International Labour Office.

Churchill, Craig, and M. J. McCord (eds.) (2012), "Current trends in microinsurance." *Protecting the poor: A microinsurance compendiumII* : 8-39.

Clarke, D. J. (2011), "A theory of rational demand for index insurance. Department of Economics", University of Oxford.

Cole, Shawn, et al (2013), "Barriers to household risk management: evidence from India." *American economic journal. Applied economics* 5.1: 104.

Cook, Philip J., and Daniel A. Graham (1977),"The demand for insurance and protection: The case of irreplaceable commodities." *The Quarterly Journal of Economics* : 143-156.

Dercon, Stefan, Jan Willem Gunning, and Andrew Zeitlin (2011), "The demand for insurance under limited credibility: Evidence from Kenya." *International Development Conference, DIAL*.

Eling, Martin, Shailee Pradhan, and Joan T. Schmit (2014), "The determinants of microinsurance demand." *The Geneva Papers on Risk and Insurance-Issues and Practice* 39.2 : 224-263.

Giesbert, Lena, Susan Steiner, and Mirko Bendig (2011), "Participation in micro life insurance and the use of other financial services in Ghana." *Journal of Risk and Insurance* 78.1 : 7-35.

Giné, Xavier, Robert Townsend, and James Vickery(2008), "Patterns of rainfall insurance participation in rural India." *The World Bank Economic Review* 22.3: 539-566.

Gollier, Christian (2003), "To insure or not to insure?: an insurance puzzle." *The Geneva Papers on Risk and Insurance Theory* 28.1 : 5-24.

Ito, Seiro, and Hisaki Kono (2010),"Why is the take-up of microinsurance so low? Evidence from a health insurance scheme in India." *The Developing Economies* 48.1 : 74-101.

Karlan, Dean, et al. (2012), "Agricultural decisions after relaxing credit and risk constraints." *National Bureau of Economic Research*.

Liu, Yanyan, and Robert J. Myers (2014), "Thedynamicsofmicroinsurancedemandin developing countries under liquidity constraints and insurer default risk." *Journal of Risk and Insurance* .

Matul, M., et al (2010), "The Landscape of Microinsurance in Africa Microinsurance Paper No. 4. Geneva", International Labour Office.

Mossin, Jan (1968), "Aspects of rational insurance purchasing." *The Journal of Political Economy* : 553-568.

Proctor, Bernadette D (2011), "Income, Poverty, and Health Insurance Coverage in the United States: 2010." *Current Population Reports. US Census Bureau*.

Schlesinger, Harris (1984), "Optimal insurance for irreplaceable commodities." *Journal of Risk and Insurance*: 131-137.

Shioshansi, F. Perry (1982), "Insurance for irreplaceable commodities." *Journal of Risk and Insurance* : 309-320.

Tomchinsky, G. (2008), "Introduction to Micro insurance Historical perspective", *A Paper*.

Lloyds of London (2009) "Insurance in developing countries exploring opportunities in microinsurance", *Microinsurance Centre*.

Swiss Re, (2010) "Microinsurance–Risk protection for 4 billion people." *Sigma* 6.

Appendix.

Proof of lemma 1.

(2) Since $\frac{U'(y-x^*)}{V'(S-D+H(x^*))} > \frac{U'(y-px^*)}{V'(S-D+H(x^*))}$, the medical expense is higher with insurance than without it.

(3) By differentiating expressions (2) and (6) with respect to wealth y, we obtain following condition:

$$-U''(y-x)dy+(U''(y-x)+V''H'^2+V'H'')dx=0 \quad (A.1)$$

Hence, without insurance, we have following relation:

$$\frac{dx}{dy}=\frac{U''(y-x)}{U''(y-x)+V''H'^2+V'H''}>0. \quad (A.2)$$

Similar to the case without insurance, the comparative static derivative of x with respectto y with insurance is as follows.

$$\frac{dx}{dy}=\frac{U''(y-px)}{pU''(y-px)+V''H'^2+V'H''}>0 \quad (A.3)//$$

Proof of proposition 3.

(1) The effect of risk size is as follows:

$$\frac{dx_1}{dD} = \frac{V''(S-D+H'_1(x_1))H'_1(x_1)}{p(1+b)^2U''(y-p(1+b)x_1)+V''(S-D+H'_1(x_1))H'_1(x_1)^2+V'(S-D+H'_1(x_1))H''_1(x_1)}>0$$
(A.4)

(2) The effect of risk probability is as follows:

$$\frac{dx_1}{dp} = \frac{-x_1(1+b)^2U''(y-p(1+b)x_1)}{p(1+b)^2U''(y-p(1+b)x_1)+V''(S-D+H'_1(x_1))H'_1(x_1)^2+V'(S-D+H'_1(x_1))H''_1(x_1)}<0$$
(A.5)

Therefore, we have the following result:

$$\frac{dpx_1}{dp}$$

$$= \frac{(p-x_1)(1+b)^2U''(y-p(1+b)x_1)+V''(S-D+H'_1(x_1))H'_1(x_1)^2+V'(S-D+H'_1(x_1))H''_1(x_1)}{p(1+b)^2U''(y-p(1+b)x_1)+V''(S-D+H'_1(x_1))H'_1(x_1)^2+V'(S-D+H'_1(x_1))H''_1(x_1)}$$

(A.6)

The sign of expression (A.6) is not clear. //

Proof of proposition 4.

(1) Let us denote the coverage and medical expenses for individuals with U_H and U_L as a_H, a_L and x_H, x_L, respectively. We also denote that $U_L(y-(1+\lambda)apx_1)=U_{L0}$, $U_L(y-(1+\lambda)ap(1+b)x_1-(1+b)x_1+a(1+b)x_1)=U_{L1}$ $U_H(y-(1+\lambda)apx_1)=U_{H0}$, and $U_H(y-(1+\lambda)ap(1+b)x_1-(1+b)x_1+a(1+b)x_1)=U_{H1}$. According to expression (25), we obtain

$$L_{a_H}=[1-(1+\lambda)p]p(1+b)x_{1H}[f'(U_{L1})U_{L1}'-f'(U_{L0})U_{L0}']-\lambda p(1+b)x_{1H}f'(U_{L0})U_{L0}'$$
$$\geq f'(U_{L0})[(1-(1+\lambda)p)p(1+b)x_{1H}(U_{L1}'-U_{L0}')-\lambda p(1+b)x_{1H}U_{L0}']=0 \quad \text{(A.7)}$$

$$L_{x_1}=-pU_H'(y-(1+\lambda)a_Hp(1+b)x_{1H}-(1+b)x_{1H}+a_H(1+b)x_{1H})$$
$$+pV'(S-D+H_1(x_{1H}))H_1'(x_{1H}) \quad \text{(A.8)}$$

Let us also denote $U_L'(a_H)$ as $U_L'(y-(1+\lambda)a_Hp(1+b)x_1-(1+b)x_1+a_H(1+b)x_1)$. Then, we transform (A.8) into (A.9).

$$L_{x_1}=-pf'(U_L'(a_H))U_L'(a_H)+pV'(S-D+H_1(x_1))H_1'(x_1) \quad \text{(A.9)}$$

As a result, if $f'(U_L(y-(1+\lambda)a_Hp(1+b)x_{1L}-(1+b)x_{1L}+a_H(1+b)x_{1L}))$

$$>\frac{U_L'(y-(1+\lambda)a_Lp(1+b)x_{1L}-(1+b)x_{1L}+a_L(1+b)x_{1L})}{U_L'(y-(1+\lambda)a_Hp(1+b)x_{1L}-(1+b)x_{1L}+a_H(1+b)x_{1L})}, \text{(A.10)}$$

then the health expense decreases.

(2) From the expression (A.10), we observe that the health expense decreases when $f'(U_L(y-p(1+b)x_{1L}))>1$ .//

Proof of proposition 5.

(1) According to expression (30), a = 1.
(2) According to proposition 4 (1), the premium is denoted that $Q=F+px^0$ at x^0. In addition, we have

$$H'(x^0) = \frac{U'(y - x^0)}{V'(S - D + H(x^0))} > \frac{U'(y - F - px^0)}{V'(S - D + H(x^0))}$$ from (31) when $F + px^0 < x^0$. Thus, $x^1 > x^0$ .//

Proof of proposition 6.

The difference between utilities can be expressed as follows:

$$Eu_3(x^1) - Eu_n(x^0) = \Delta U + p\Delta V \qquad \text{(A.11)}$$

where $\Delta U = U(y - F - px^1) - [pU(y - x^0) + (1 - p)U(y)]$

$\Delta V = V(S - D - H(x^1)) - V(S - D + H(x^0))$

We already know that $x^1 > x^0$; thus, $\Delta V > 0$. In addition, by concavity of utility function, $pU(y - x^0) + (1 - p)U(y) = U(y - px^0 - risk\ \ premium)$. Therefore, if $F + px^1 \leq px^0 + risk$ or ΔV is sufficiently large, then $Eu_3(x^1) > Eu_2(x^0)$. People do not buy insurance when $Eu_3(x^1) < Eu_n(x^0)$ .//

Figure 1.

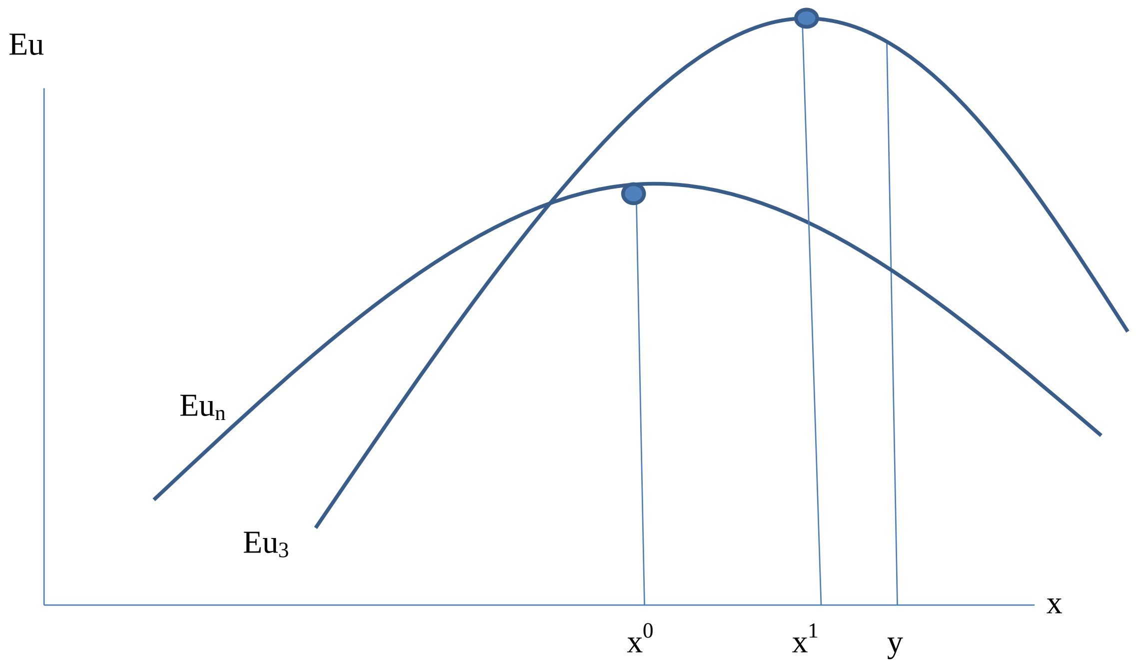

Figure 2.