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Wealth Effects on Self-Insurance and Self-Protection against Monetary and Nonmonetary Losses

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Abstract

This paper considers the wealth effects on self-insurance and self-protection activities against possible losses of monetary wealth such as properties and nonmonetary wealth such as health. Increased initial income or monetary wealth decreases the demand for self-insurance against monetary wealth loss under the decreasing absolute risk aversion assumption, and has an ambiguous effect on self-protection. However, increased initial monetary wealth increases both self-insurance and self-protection against health loss, explaining empirical trends, if wealth and health are complements. When multiple self-insurance activities against both types of losses are considered, the effect of an increase in initial monetary wealth on self-insurance against health loss remains the same, but the effect on self-insurance against wealth loss depends on the preferences.

Key words: self-insurance, self-protection, wealth loss, health loss, wealth effects

JEL Classification No.: D81, G22

1. Introduction

Wealth and assets are subject to possible loss, and rational individuals desire to invest in self-insurance activities that reduce the size of loss and in self-protection activities that reduce the probability of loss. For example, houses may be burned by fires or damaged by storms, resulting in a wealth loss. To reduce possible damages caused by fires and storms, property owners may purchase fire extinguishers and board up windows. To reduce the probability of thefts, property owners install a burglar alarm system. Since Ehrlich and Becker [1972] first analyzed self-insurance and self-protection, it has received much attention from economists in various fields. As the examples above indicate, (monetary) wealth loss such as property loss has been implicitly and explicitly the main subject of analyses in the self-insurance and self-protection literature.[1]

However, nonmonetary wealth is also subject to loss. For example, health loss may occur due to diseases and accidents, and rational individuals again invest in self- insurance and self-protection against possible health loss. Air bags in automobiles reduce health loss in case of automobile accidents, and even save lives sometimes. Helmets protect motor cyclists against possible health loss. Regular medical checkups may result in early detection of diseases and hence early treatment that decreases health loss. Other nonmonetary wealth losses include defamation and legal punishment such as imprisonment, and one may hire competent lawyers as self-insurance, who may reduce the penalties in case of conviction. Judging by the magnitude of expenditures on safety devices in automobiles such as air bags and anti-lock brake systems, medical checkups and other preventive medical cares, and settlement of legal disputes, these types of self-insurance and self-protection activities against health loss and other nonmonetary wealth losses appear not less important than traditional self-insurance and self-protection investment against (monetary) wealth loss. In addition, these self-insurance and self-protection activities against nonmonetary wealth loss have been increasingly more important, as incomes increase. Despite the significance of those activities against such nonmonetary wealth loss, to the best of our knowledge those activities have not been analyzed in the literature.

This paper considers one aspect of the model with wealth loss and nonmonetary wealth loss although the model here has a potential to extend the literature in various ways. In particular, the question concerns the effects of an increase in initial income or (monetary) wealth on self-insurance and self-protection investment. In the case of traditional self-insurance against wealth loss, the effects of increased initial wealth on the demand for self-insurance depend on preferences toward risk. If the utility function satisfies the decreasing absolute risk aversion assumption, higher initial wealth reduces the demand for self- insurance. This is because one becomes less risk averse and hence desires less insurance as one becomes wealthier under the assumption. With the increasing absolute risk aversion assumption, the opposite result holds and an increase in initial wealth increases the demand for self-insurance. Since the former assumption is considered more reasonable, increased initial wealth decreases the demand for self-insurance against wealth loss. However, in the case of self-insurance against health loss or other nonmonetary wealth losses, increased initial wealth leads to greater demand for self-insurance, a result consistent with casual empiricism, if wealth and nonmonetary wealth are complements. The reason is simply that an increase in initial wealth increases the marginal utility of health due to complements, giving greater incentives to invest in self-insurance.

As for self-protection against traditional wealth loss, an increase in initial wealth decreases the marginal utility cost of self-protection due to decreasing marginal utility. It also decreases the marginal utility benefit, the difference in utilities between the no-loss state and the loss state, due to decreasing marginal utility. An increase in initial wealth thus may increase or decrease self-protection against traditional wealth loss. In the case of self-protection against health loss, an increase in initial wealth loss decreases the marginal utility cost, as is the case of self-protection against traditional wealth loss. However, it increases the marginal utility benefit if wealth and health are complements, because an increase in initial wealth increases the marginal utility benefit of the no-loss state with a higher level of health while it decreases the marginal utility benefit of the loss state with a lower level of health. An increase in initial wealth thus unambiguously increases self-protection against health loss if wealth and health are complements.

A number of papers have considered comparative statics of self- insurance and self-protection. Dionne and Eeckhoudt [1985], Briys and Schlesinger [1990], Lee [1998], Jullien et al. [1999], and Godfroid et al. [1999] study the effects of increased risk aversion on self-insurance and self-protection. Sweeney and Beard [1992] analyze the effects of an increase in initial wealth on self-protection, but not on self-insurance. More importantly, these papers consider only monetary wealth.

The paper is organized as follows. The next section analyzes the wealth effects on self-insurance, and Section 3 considers self- protection. As an extension, Section 4 discusses the wealth effects on self-insurance-cum-protection activities and on multiple self-insurance activities. Section 5 addresses policy implications, and the last section offers a conclusion.

2. Self-insurance

2.1. The model

A risk-averse individual has preferences over (monetary) wealth y and health h. The preferences are represented by the utility function

$$U(y, h). \tag{1}$$

The utility function is increasing in both arguments and concave, reflecting the assumption that the individual is risk averse. This specification of the utility function is standard in the health economics literature (for example, Phelps [1992, Ch. 2]; Bleichrodt and Quiggin [1999]; Dolan and Edlin [2002]). Wealth y in the utility function (1) is measured in monetary units, but health is not. As mentioned in the introduction, the analysis applies to other types of nonmonetary wealth that individuals care about, and h should be interpreted more broadly than one's health stock although health is perhaps the most important nonmonetary wealth.

In the literature on the valuation of risks to life and health, the value of life and health is measured by the difference in utility of incomes between the healthy state and the unhealthy state (for example, Evans and Viscusi [1991a, 1991b]; Sloan et al. [1998]; Eeckhoudt and Hammitt [2001]). This state-dependent utility model, however, is not appropriate here, because health is implicit and subsumed, and self-insurance against health loss cannot be analyzed.

The individual may lose part or all of wealth or health. Wealth loss may result from the damages to property such as houses and automobiles. Health loss may result from illness and accidents. A loss occurs with probability p, and let $\ell(s)$ and $m(s)$ denote the magnitude of wealth loss and health loss, respectively, which depend on self-insurance investment, s. For the subsequent analyses, it is important to recognize that $\ell(s)$ is measured in monetary units and will be subtracted from initial wealth y_o while $m(s)$ is not and will be subtracted from initial health h_o. By the definition of self-insurance, $\ell'(s) < 0$ and $m'(s) < 0$, so that both losses decrease with self-insurance investment. The cost of self-insurance s is written as $c(s)$ in monetary units with $c'(s) > 0$. For a unique optimal choice of self-insurance later, assume $\ell''(s) \geq 0, m''(s) \geq 0$ and $c''(s) > 0$. In analyzing the income or wealth effects on self-insurance investment, we allow for three possibilities of loss occurring; (i) wealth loss only, (ii) health loss only, and (iii) both wealth loss and health loss. The last case is complicated and will be briefly mentioned in Section 4.

2.2. Wealth loss

Although the case with wealth loss only is not the focus of this paper, this section considers this standard case as a benchmark for later analyses. Wealth when a loss occurs and wealth when no loss occurs read as, respectively,

$$y_1 \equiv y_o - c(s) - \ell(s); \quad y_2 \equiv y_o - c(s). \tag{2}$$

The individual's problem is to choose s, called SIWL (self-insurance against wealth loss), to maximize expected utility

$$W = pU(y_1, h_o) + (1-p)U(y_2, h_o). \tag{3}$$

In writing expected utility W, use is made of the fact that health stock is h_o in both states, given no health loss in this section. The first-order condition is

$$E(s, y_o) \equiv \frac{dW}{ds} = -pU_{1y}\ell' - [pU_{1y} + (1-p)U_{2y}]c' \leq 0, \tag{4}$$

where $U_i \equiv U(y_i, h_o)$, and subscripts y in U_{iy} denote partial derivatives of U_i with respect to y_i, and the argument of $c(s)$ and $\ell(s)$, s, is suppressed for simplicity. To proceed with the comparative static analyses, interior solutions are assumed and hence the equality is assumed to hold in (4). A sufficient condition for interior solutions is $-p\ell'(0) > c'(0)$, stating that the marginal reduction in expected loss exceeds the marginal cost of self-insurance at $s = 0$.[2] The condition (4) means that at the optimal level of SIWL, the marginal utility benefit from the increase in wealth through the reduction in loss, $-pU_{1y}\ell' > 0$, must equal the marginal utility cost of the decrease in wealth due to the cost of self- insurance, $[pU_{1y} + (1-p)U_{2y}]c'$.

To examine the effects of an increase in initial wealth y_o on SIWL, we totally differentiate (4), giving

$$\begin{aligned} \frac{ds}{dy_o} &= -\frac{E_{y_o}}{E_s(s, y_o)} = -\frac{1}{E_s(s, y_o)}[-pU_{1yy}(c' + \ell') - (1-p)U_{2yy}c'] \\ &= -\frac{1}{E_s(s, y_o)}\left[(1-p)U_{2y}c'\left(\frac{U_{1yy}}{U_{1y}} - \frac{U_{2yy}}{U_{2y}}\right)\right] \\ &= -\frac{1}{E_s(s, y_o)}[(1-p)U_{2y}c'(A_2 - A_1)], \end{aligned} \tag{5}$$

where

$$\begin{aligned} E_s(s, y_o) = \frac{d^2W}{ds^2} &= pU_{1yy}(c' + \ell')^2 - pU_{1y}(c'' + \ell'') \\ &\quad + (1-p)U_{2yy}(c')^2 - (1-p)U_{2y}c'' < 0. \end{aligned} \tag{6}$$

The inequality follows because of concavity of U, along with $\ell''(s) \geq 0$ and $c''(s) > 0$. The second-order condition is thus satisfied. The equality in the second line of (5) obtains by substituting $-p(c' + \ell') = (1 - p)c'U_{2y}/U_{1y}$ from the first-order condition (4), and the last equality uses the definition of the coefficient of absolute risk aversion, $A_i \equiv -U_{iyy}/U_{iy}$. Observe that the difference in the coefficients of absolute risk aversion between the two states stems only from the difference in wealth, because health stock is the same h_o across two states. Since $E_s < 0$ from (6), the sign of ds/dy_o coincides with the sign of $(A_2 - A_1)$. Given that $y_1 < y_2$ in (2), the utility function satisfies DARA (decreasing absolute risk aversion), CARA (constant absolute risk aversion), IARA (increasing absolute risk aversion) respectively if $A_1 > A_2$, $A_1 = A_2$, $A_1 < A_2$. The following result then can be stated:

Proposition 1: *An increase in initial wealth y_o decreases (does not change, increases) self-insurance against wealth loss if the utility function satisfies DARA (CARA, IARA)*

The proposition shows that even the simple model of self-insurance does not generate an unambiguous comparative static result about the relationship between initial wealth and SIWL. The intuition may be gained as follows. Since marginal utility decreases with wealth due to risk aversion, an increase in initial wealth reduces both marginal benefit and marginal cost. Hence, the effect of an increase in initial wealth on SIWL cannot be determined without further assumptions. With DARA, an increase in initial wealth y_o has a greater impact in the bad state with lower wealth y_1 than in the good state with higher wealth y_2. In this case, an increase in initial wealth then reduces the marginal utility benefit of an increase in SIWL more than the marginal utility cost, decreasing the incentive to invest in SIWL. More intuitively, DARA implies that one becomes less risk averse as one becomes wealthier. Thus, an increase in initial wealth reduces SIWL. With IARA, the opposite holds, and an increase in initial wealth increases the incentive to invest in SIWL. With CARA, such wealth effects are absent, and a change in initial wealth has no effect on SIWL.

DARA is known to be more plausible, because it implies, for example, that a wealthier person is willing to invest more in risky assets. For this reason, we assume DARA in the subsequent analysis. Under DARA, as in the proposition, the level of SIWL falls with initial wealth.

While the result in the proposition is simple, to the best of our knowledge it has not been formally analyzed in the literature. The proposition, however, can be related to the demand for insurance in the literature (for example, Mossin [1968]; Schlesinger [2000]). To this end, assume that both the loss function and the cost function are linear, so that $c(s) = ks$ and $\ell(s) = \ell_o - s$ with ℓ_o denoting the initial loss in the absence of self-insurance. Interpreting s as an insurance coverage and k as a unit price of coverage, the choice of SIWL is equivalent to the purchase of insurance coverage s. The result in the insurance literature then applies. In particular, an increase in wealth y_o decreases (increases) s, insurance coverage and hence SIWL, with DARA (IARA). With this interpretation, Proposition 1 may be viewed as an extension of the traditional result in the insurance models to a convex pricing model.

2.3. Health loss

This section considers the case where only health loss occurs. Health when a loss occurs and health when no loss occurs are

$$h_1 = h_o - m(s); \quad h_2 = h_o. \tag{7}$$

The individual then chooses s, called SIHL (self-insurance against health loss), to maximize[3]

$$W = pU(y_o - c(s), h_1) + (1 - p)U(y_o - c(s), h_2). \tag{8}$$

In (8), wealth is the same and $y_o - c(s)$ across two states, given no wealth loss in this section. The first-order condition for an interior maximum is

$$F(s, y_o) \equiv \frac{dW}{ds} = -pU_{1h}m' - [pU_{1y} + (1 - p)U_{2y}]c' = 0. \tag{9}$$

The interpretation of the condition is analogous to that of (4). At the optimal s, the marginal utility benefit from the increase in health in the bad state through the reduction in health loss must equal the marginal utility cost of the decrease in wealth due to the increase in cost of SIHL.

In a manner analogous to (5), total differentiation of (9) yields

$$\frac{ds}{dy_o} = -\frac{F_{y_o}}{F_s} = -\frac{1}{F_s}\{-pU_{1yh}m' - [pU_{1yy} + (1 - p)U_{2yy}]c'\}. \tag{10}$$

Since $F_s < 0$ by the second-order condition, the sign of ds/dy_o is the same as that of the numerator.[4] As the individual is risk averse ($U_{1yy} < 0$ and $U_{2yy} < 0$), the last two terms are positive. The sign of U_{1yh} in the first term depends on whether health and wealth are complements or substitutes. However, the first term becomes nonnegative if $U_{yh} \geq 0$, given $m' < 0$. This discussion leads to the following result:

Proposition 2: *If $U_{yh} \geq 0$ (wealth and health are complements), an increase in initial wealth y_o increases self-insurance against health loss.*

Unlike SIWL in the previous section, the effect of increased initial wealth on SIHL does not depend on the preferences toward risk, but on the sign of U_{yh}. The result has a simple intuition. An increase in initial wealth reduces the marginal utility cost of an increase in SIHL, $[pU_{1y} + (1 - p)U_{2y}]c'$, due to risk aversion, as in the previous section with SIWL. But the same increase in initial wealth may increase, may not affect, or may decrease the marginal utility benefit of the increase in SIHL, $-pU_{1yh}m'$, depending on the sign of U_{1yh}. Suppose that $U_{yh} = 0$ and the utility function is separable between wealth and health, and an increase in wealth does not affect the utility associated with health. In this case, increased initial wealth increases the desire to invest in SIHL because of the reduction in the marginal utility cost of SIHL. If $U_{yh}(y, h) > 0$ so that wealth and health are complements, it reinforces the above result, because an increase in initial wealth also increases the marginal utility benefit from higher health stock due to the reduction of health loss by the increase in SIHL, further increasing the incentive to invest in SIHL. Taken together, if $U_{yh} \geq 0$, as stated in the proposition, SIHL increases with initial wealth. However, if $U_{yh}(y, h) < 0$ and wealth and health are substitutes, an increase in initial wealth decreases the marginal utility benefit of the increase in SIHL. An increase in initial wealth then reduces both the marginal cost and the marginal benefit of an increase in SIHL, making the effects of increased initial wealth on SIHL ambiguous.

Both assumptions about the sign of U_{yh} are possible, and a complete analysis of the wealth effects on SIHL in Proposition 2 requires the discussion of the case with $U_{yh} < 0$. However, an analysis of the case with $U_{yh} < 0$ will not be pursued here for the following reasons.[5] The analysis of this case involves various signs of third derivatives such as U_{yyh} and U_{hhy}. The assumptions about these third derivatives are neither simpler nor less restrictive than the assumption of $U_{yh} \geq 0$ in Proposition 2. Basically, given the nature of the question under consideration, one has to have some knowledge of cross partial derivatives of the utility function whether they are second or third derivatives. In addition, the interpretation of those third derivatives are less intuitive than $U_{yh} \geq 0$ or $U_{yh} < 0$. More importantly, the complements assumption seems more reasonable and well received. An argument for the assumption is that one may be able to enjoy wealth better when one is in good health than in bad health. In fact, this is the standard assumption in the literature on the valuation of risks to life and health (Evans and Viscusi [1991a, 1991b]; Sloan et al. [1998]; Eeckhoudt and Hammit [2001]). This is also the standard assumption in health production models (Ettner [1996]; Bolin et al. [2002]).

In any case, if the utility function is separable, or wealth and health are not strong substitutes, then the result in the proposition follows. Consequently, an increase in initial wealth decreases SIWL, if DARA is accepted as a reasonable assumption, in the previous section, but it increases SIHL in this section if $U_{yh} \geq 0$. This result may provide an explanation for why the demand for SIHL has increased with wealth, as mentioned in the introduction.

3. Self-protection

3.1. Wealth loss

Self-protection, x, reduces the probability of loss, $p(x)$, and it is assumed that $p'(x) < 0$ and $p''(x) \geq 0$. As is standard in the literature, self-protection does not alter the size of loss, ℓ. Wealth in (2) is then modified as

$$y_1 \equiv y_o - c(x) - \ell; \quad y_2 \equiv y_o - c(x). \tag{11}$$

The individual's problem is to choose x, called SPWL (self-protection against wealth loss), to maximize expected utility

$$W = p(x)U(y_1, h_o) + (1 - p(x))U(y_2, h_o). \tag{12}$$

The first-order condition for an interior maximum is

$$J(x, y_o) \equiv \frac{dW}{dx} = p'(U_1 - U_2) - [pU_{1y} + (1-p)U_{2y}]c' = 0, \tag{13}$$

where the argument of $p(x)$ and $c(x)$, x, is suppressed for simplicity. Because of concavity of U, along with $p'' \geq 0$ and $c'' > 0$, $J_x < 0$ and the second-order condition is satisfied. The condition (13) means that at the optimal level of SPWL, the marginal utility benefit from increasing the probability of the good state and decreasing the probability of the bad state, $p'(U_1 - U_2) > 0$, must equal the marginal utility cost of the decrease in wealth due to the cost of self-protection in both states, the remaining term in (13).

As in the previous section, total differentiation of (13) gives

$$\frac{dx}{dy_o} = -\frac{J_{y_o}}{J_x} = -\frac{1}{J_x}\{p'(U_{1y} - U_{2y}) - [pU_{1yy} + (1-p)U_{2yy}]c'\}. \tag{14}$$

Given $J_x < 0$, the sign of dx/dy_o depends on the numerator. The first term, $p'(U_{1y} - U_{2y})$, is negative and shows that an increase in initial wealth y_o decreases the marginal utility benefit from an increase in SPWL. That is, as y_o increases, the difference in the utilities between the good state and the bad state decreases due to decreasing marginal utility, decreasing the benefit of self-protection. The second term, $(pU_{1yy} + U_{2yy})c'$, is also negative and an increase in y_o decreases the marginal utility cost. Since an increase in y_o decreases both the marginal benefit and the marginal cost, it may increase or decrease SPWL.[6]

3.2. *Health loss*

As in (11), health is modified as

$$h_1 = h_o - m; \quad h_2 = h_o. \tag{15}$$

The individual then chooses x, called SPHL (self-protection against health loss), to maximize

$$W = p(x)U(y_o - c(x), h_1) + (1 - p(x))U(y_o - c(x), h_2). \tag{16}$$

The first-order condition for an interior maximum is

$$K(x, y_o) \equiv \frac{dW}{dx} = p'(U_1 - U_2) - [pU_{1y} + (1-p)U_{2y}]c' = 0. \tag{17}$$

The interpretation of the condition is analogous to that of (13). Total differentiation of (17) yields

$$\frac{dx}{dy_o} = -\frac{K_{y_o}}{K_x} = -\frac{1}{K_x}\{p'(U_{1y} - U_{2y}) - [pU_{1yy} + (1-p)U_{2yy}]c'\}. \tag{18}$$

Assuming that $K_x < 0$ and the second-order condition holds, the sign of dx/dy_o is the same as that of the numerator.[7] The second term in the numerator, $[pU_{1yy} + (1-p)U_{2yy}]c'$, is negative, and an increase in y_o decreases the marginal utility cost of SPHL again due to the decreasing marginal utility of wealth. However, the first term, $p'(U_{1y} - U_{2y})$, depends on whether health and wealth are complements or substitutes.

If $U_{yh} \geq 0$, then the first term becomes positive and an increase in y_o increases the marginal utility benefit of SPHL. The reason is that the marginal utility of health increases with wealth. An increase in initial wealth y_o thus increases the utility more in the good state with a higher level of health than in the bad state with a lower level of health. An increase in y_o thus increases the marginal utility benefit of SPHL, while it decreases the marginal utility cost. Therefore, in this case, $dx/dy_o > 0$. Alternatively, if $U_{yh} < 0$, the first term becomes negative and an increase in y_o decreases the marginal utility benefit of SPHL. In this case, an increase in y_o has an ambiguous effect on SPHL. This discussion leads to the following result:

Proposition 3: *If $U_{yh} \geq 0$ (wealth and health are complements), an increase in initial wealth y_o increases self-protection against health loss.*

The proposition again shows that the wealth effect on self-protection against health loss differs from that against wealth loss. Propositions 2 and 3, taken together, show that the wealth effect on both SIHL and SPHL depends on whether wealth and health are complements or not. However, the conditions governing the wealth effects on SIWL differ from those on SPWL.

4. Extensions

This section considers a number of extensions. To conserve space, the basic idea is illustrated without detailed analyses.[8] While self-insurance and self-protection are distinct concepts and have been analyzed separately, many activities reduce both the probability and the magnitude of loss. For example, good brakes may reduce both the probability of accident and the magnitude of loss if it occurs. Regular exercises may decrease the probability of a disease and the severity of illness if it occurs. These activities are called self-insurance-cum-protection (SIP).[9] In the case of SIPWL, investment s enters both $p(s)$ and $\ell(s)$. Since SIPWL is a combination of SIWL and SPWL, and since no simple condition can determine the wealth effect on SPWL, as in Section 3.1, the effect of increased wealth on SIPWL is ambiguous. By contrast, SIPHL increases with wealth if $U_{yh} \geq 0$, because both SIHL and SPHL increase with wealth under the condition. The analyses in the previous sections thus extend to these more realistic cases where one activity can reduce both the probability of a loss and the size of the loss.

As another extension, we consider a case where both wealth loss and health loss occur. In this case, a rational individual may invest both in SIWL and SIHL. For instance, one may invest in sprinklers against possible wealth loss and in medical check ups against health loss. Letting s_w and s_h denote SIWL and SIHL respectively, wealth becomes then

$$y_1 = y_o - c_w(s_w) - c_h(s_h) - \ell(s_w); \quad y_2 = y_o - c_w(s_w) - c_h(s_h), \tag{19}$$

and health stock becomes $h_1 = h_o - m(s_h)$ and $h_2 = h_o$, as before. Letting p_w and p_h denote the probability of wealth loss and that of health loss, and assuming that two types of losses occur independently, expected utility reads as

$$\begin{aligned} W = {} & p_w p_h U(y_1, h_1) + p_w(1 - p_h)U(y_1, h_2) \\ & + (1 - p_w)p_h U(y_2, h_1) + (1 - p_w)(1 - p_h)U(y_2, h_2). \end{aligned} \tag{20}$$

The first term of W represents the utility if both wealth loss and health loss occur. The second one represents the utility if wealth loss occurs but not health loss, and the third and the fourth terms are interpreted in a similar manner.

Unlike in the previous sections that consider a single self-insurance activity against wealth loss or against health loss, optimal s_w and s_h jointly maximize the expected utility W in (20). As a result, an increase in wealth directly affects SIHL and indirectly SIHL through the effect on SIWL, because an increase in wealth alters both SIHL and SIWL, and because SIHL and SIWL are jointly determined. In other words, the effects of increased wealth on SIHL, s_h, read as

$$\frac{ds_h}{dy_o} = \frac{\partial s_h}{\partial y_o} + \frac{\partial s_h}{\partial s_w}\frac{\partial s_w}{\partial y_o}. \tag{21}$$

The first term, direct effect, is positive if $U_{yh} \geq 0$, as in Section 2.3. The analysis of the wealth effects on SIHL in Section 2.3 thus carries over.[10] By contrast, the wealth effects on SIWL become much more complicated, and DARA or IARA is not sufficient to determine the wealth effects. A similar result obtains if both SPWL and SPHL are simultaneously considered. That is, SPHL increases with wealth if $U_{yh} \geq 0$ while the wealth effect on SPWL is ambiguous and complicated.

5. Discussion

The analyses have some policy implications. While self-insurance or self-protection investment by an individual has been considered in isolation of other individuals, such individual investment sometimes affects other individuals. For example, smoking poses health risk not only to smokers but also to other individuals, known as the second-hand smoking problem. Any individual investment to reduce or stop smoking thus benefits smokers and other individuals as well, and such investment creates a positive externality. As well known in public economics, an individual invests too little relative to the socially efficient level by ignoring the marginal external benefit conferred on other individuals. A solution that helps achieve an efficient allocation is to subsidize such investment so that each individual invests an efficient level. Investment to reduce or stop smoking is certainly considered self-insurance or self-protection or self-insurance-cum-protection, and a subsidy that lowers the price of such investment will increase it and benefit society, because both the price effect and the wealth/income effect work in the same direction, given that SIHL or SPHL is a normal good according to the analyses in the previous sections. For example, nicotine replacement treatments such as the use of nicotine patches are an investment to reduce or stop smoking, and should be subsidized to increase such investment. The same comment applies to any investment to reduce health risk to other individuals through sexually transmitted diseases.

SIWL or SPWL or SIPWL may also create an external benefit. Fire extinguishers in a house reduce the damage to the house in case of a fire, and decrease the chance that the fire spreads to other houses. However, when SIWL creates a positive externality, it may not be necessarily efficient to subsidize SIWL. The subsidy will lower the price of SIWL, which increases SIWL by the substitution effect. However, the lower price increases real wealth, and an individual decreases SIWL due to inferiority of SIWL. In this case, the substitution effect and the wealth effect work in opposite directions. If the substitution effect dominates, the subsidy increases SIWL and hence improves efficiency. If the wealth effect dominates, SIWL becomes a Giffen good. In this case, a tax rather than a subsidy is the appropriate policy that increases efficiency.[11]

6. Conclusion

The paper has analyzed the effects of increased initial wealth on self-insurance and self-protection. The analyses have shown that an increase in initial wealth reduces SIWL with DARA, but increases SIHL if wealth and health are complements. As for self-protection, SPHL increases with wealth if wealth and health are complements, but SPWL may increase or decrease with wealth. An implication of the analyses is that the demand for self-insurance or self-protection against nonmonetary wealth loss such as health loss tends to increase with wealth or incomes. This prediction stands in contrast with the result in the standard model with wealth loss only.

While the paper focuses on the effects of increased initial wealth on self insurance and self-protection against possible losses, it may have a larger implication. As the analysis has demonstrated in the case of the wealth effects on self-insurance and on self-protection, the consideration of nonmonetary wealth loss may modify the existing results in other areas of risk and uncertainty in a nontrivial manner. In addition, nonmonetary wealth has been increasingly more important, and accordingly expenditures on moderating nonmonetary wealth loss have been on the rise. Nonmonetary wealth loss thus appears to deserve careful attention, and more research on this issue may produce new insights.

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Notes

1. Monetary wealth such as house is measured in monetary units and is simply called wealth. Nonmonetary wealth such as health is not measured in monetary units.
2. The condition implies $-pU_{1y}\ell'(0) > U_{1y}c'(0) > [pU_{1y} + (1-p)U_{2y}]c'(0)$, because $U_{1y} > U_{2y}$ due to the decreasing marginal utility of wealth. The inequality inturn implies $E(0, y_o) > 0$ in (4), and the condition in (4) holds as equality.
3. Since the expression for the expected utility in this section differs from that in the last section, it is ideal to use anotation different from W. However, for simplicity, we keep the same notation W, as there appears no possibility of confusion. For the same reason, we continue to use s to denote SIHL although it was already used to denote SIWL in the last section.
4. It can be shown that $d^2W/ds^2 = F_s = -pU_{1h}m'' - [pU_{1y} + (1-p)U_{2y}]c'' + pm'[U_{1hh}m' + U_{1yh}c'] + [pU_{1yy}c' + pU_{1yh}m' + (1-p)U_{2yy}c']c'$. The sign of F_s cannot be determined in general, and the second-order condition may not hold automatically due to the terms involving U_{yh}. A sufficient condition for the satisfaction of $F_s < 0$ is that health and wealth are complements ($U_{yh} \geq 0$).
5. An earlier version of this paper presented a detailed analysis of this case, and is available from the author.
6. Sweeney and Beard [1992] show that the sign of dx/dy_o depends on the preferences toward risk and the magnitude of the probability of loss, $p(x)$, with x chosen optimally. However, since the conditions are complicated, and since the main focus is on SPHL, they are not discussed here.
7. A simple sufficient condition for $K_x < 0$ is that health and wealth are complements ($U_{yh} \geq 0$).
8. An earlier version of this paper provided formal analyses.
9. Lee [1998] analyzes the effects of increased risk aversion on self-insurance-cum-protection activities.
10. The second indirect effect is ambiguous. However, the direct effect turns out to outweigh the indirect effect, and $ds_h/dy_o > 0$ so that SIHL increases with wealth as long as $U_{yh} \geq 0$. The proof of this claim was provided in an earlier version of this paper, and is available from the author upon request.
11. Which effect dominates cannot be determined in general. However, when the cost function $c(s)$ is linear, a necessary and sufficient condition for SIWL not to be a Giffen good is identical to that for insurance not to be a Giffen good. The condition is stated in Briys et al. [1989], and it basically limits the magnitude of absolute risk aversion, so that the substitution effect always dominates the wealth effect.

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