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KINKED UTILITY AND THE DEMAND FOR HUMAN WEALTH AND LIABILITY INSURANCE

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The paper advances the hypothesis that the 'gross wealth' von Neumann/Morgenstern utility function is characterized by a horizontal branch for wealth levels below the socially guaranteed minimum wealth and analyses the implications of this property for human wealth and liability insurance. It turns out that the attractiveness of these kinds of insurance might, even for risk-averse people, be too low to satisfy the premium requirements of private insurance companies.

1. The problem

In the last twenty years a number of articles on the theory of the demand for insurance have been published[1] and as a result a fairly realistic theory of property insurance has been developed. However, little attention has so far been paid to a peculiarity of human wealth and liability insurance[2] which is the subject of this paper.

Human wealth insurance protects a person against random deductions from the present value of his lifetime labour income stream. Examples are health and unemployment insurance. Liability insurance provides protection against compensation for damages inflicted on third parties, of which examples are automobile and personal liability insurance.

*The idea presented here originates from a paper that the author gave at a course in Insurance Marketing, led by E. Helten. I gratefully acknowledge comments by the participants of this course, the participants of a seminar given at the University of Western Ontario, as well as the referees of this journal.

[1]For examples of studies of insurance demand, when the risk is exogenous, see Borch (1961, 1962), Arrow (1965), Lees and Rice (1965), Pashigian, Schkade, and Menefee (1966), Mossin (1968), Smith (1968), Gould (1969), von Lanzenauer and Wright (1975). The most comprehensive study available now is Arrow (1974). Cf. also the original expected utility approach by Barrois (1834, pp. 259–282) as well as the considerations of Bernoulli (1738) concerning the insurance problem. Recent research has concentrated on various types of insurance induced behavior changes, which tend to increase the risks to be insured. Cf. e.g., Pauly (1968), Spence and Zeckhauser (1971), Seidl (1972), Ehrlich and Becker (1972), Helpman and Laffont (1975), and Sinn (1978).

[2]Exceptions are Seidl (1972, pp. 443–445) and Smith (1968, pp. 75–77) who have already provided some analysis of liability insurance. Cf. also Hamburg and Matlack (1968).

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In contrast to property risks, the crucial feature of human wealth and liability risks is that the choice between being uninsured or buying an insurance contract is not necessarily the choice between bearing a risk oneself or transferring it for a premium to the company. The reason is that there exist lower boundaries for a person's wealth, where wealth is defined as the sum of material and human wealth.[3] These boundaries imply that even when a person is uninsured it is possible that a part of a potential loss will be borne by other parties.

A natural lower boundary for wealth is zero, simply because a person cannot lose more than he possesses. In reality, however, the lower boundary is usually significantly higher: all societies with developed economies have laws, customs, and institutions, which guarantee each of its members an income stream which provides a socially acceptable minimum living standard. The present value of this stream is the lowest possible personal wealth level, regardless how large a loss there would be in the case of uninsured damage.

For property insurance, the guaranteed minimum wealth level is usually irrelevant. If we assume that the human wealth of people exceeds this level, which is realistic, then the probability distributions of wealth among which a decision-maker has to choose in the case of property insurance cover only the range above the guaranteed minimum wealth. In contrast, in the case of liability and human wealth insurance the guaranteed minimum wealth plays an important rôle in determining individual behaviour. Suppose, for example, a person faces a liability risk where the possible loss exceeds the difference between his initial wealth and the guaranteed minimum wealth. In such instances, even without insurance, the person liable avoids part of the loss which, of necessity, is borne by the person sustaining the damage. Alternatively, consider a person who possesses human, but no material wealth, and who faces, through permanent medical incapacity, the loss of all future employment (that is to say faces the risk of losing his human wealth). Such a person, in a developed economy, can be confident that welfare authorities will, if necessary, underwrite his loss up to the extent of the guaranteed subsistence level. Thus here too, even without private insurance, a part of the loss is borne by others.

Our analysis of human wealth and liability insurance yields some unexpected aspects of the insurance demand behaviour of an individual. The most striking result is certainly the possibility that, even under a fair rating system, a risk-averter may choose not to buy any insurance. A second aspect worth noting is that if the purchaser has the freedom to choose the degree of coverage it is never optimal for him to choose a low degree of coverage (regardless of the premium required by the company) if the possible loss is large enough or, conversely, if he has sufficiently low initial wealth. Our

[3]Human wealth is defined as the present value of a person's lifetime labour income stream.

analysis shows also that a person whose preferences are characterized by 'decreasing absolute risk-aversion' might well increase the level of his insurance coverage if his wealth increases, notwithstanding conventional theory which tells us the opposite.

2. The kinked utility curve

In this section we formally introduce the guaranteed existence minimum wealth, call it M ($M \geqq 0$), into a decision theoretic framework for evaluating probability distributions.

The considerations in the introductory section suggest that in the presence of a guaranteed minimum wealth we have to distinguish between two kinds of wealth distributions which a decision maker faces. One is a gross distribution describing the wealth levels that would be reached without the guaranteed minimum wealth and the other is a net distribution indicating which wealth levels result when the guaranteed minimum wealth is taken into account. Let a person's gross distribution be described by the random variable V. Then his corresponding net distribution is obviously given by

$$V^* = \begin{Bmatrix} V, & V \geqq M \\ M, & V \leqq M \end{Bmatrix}, \qquad M \geqq 0. \tag{1}$$

Consider now a decision-maker who has to choose from an opportunity set of gross distributions V and assume that this person is in principle a globally risk-averse expected utility maximizer. There are two possible ways to model his choice. One is to calculate for each V the corresponding V^* according to rule (1) and then to apply the criterion

$$\max E[U^*(V^*)], \tag{2}$$

where $U^*(\cdot)$, $U^{*\prime}(\cdot) > 0$, $U^{*\prime\prime}(\cdot) < 0$, is his net wealth utility function and E the expectation operator. The other possibility is to construct an indirect utility function for gross wealth,[4]

$$U(V) = \begin{Bmatrix} U^*(V), & V \geqq M \\ U^*(M), & V \leqq M \end{Bmatrix}, \tag{3}$$

and then to apply the rule

$$\max E[U(V)]. \tag{4}$$

[4]We assume throughout our analysis that $U^*(\cdot)$ is bounded in the range $M \leqq V \leqq A$, where A is the decision-maker's initial wealth.

Of course both ways lead to the same result, since for each element of the opportunity set $E[U(V)]=E[U^*(V^*)]$. The second approach, however, makes the analysis easier and is the one adopted in this paper.

The graph of the gross wealth utility function (3) is given in fig. 1. To the right of M, it is identical with that of the original utility function, but for wealth levels below M it takes the form of a horizontal line joining the net wealth curve at $U^*(M)$.

Fig. 1 shows that there is a characteristic kink in the gross wealth utility function which destroys the overall concavity of utility which we normally assume for a risk-averse decision-maker. It is readily apparent that in evaluating a gross probability distribution, part of which covers the region to the left of M, a decision-maker might well behave as a risk-lover although, with respect to the corresponding net distribution, he is in fact a risk-averter. The implications of the phenomenon for insurance demand are investigated in the next two sections.

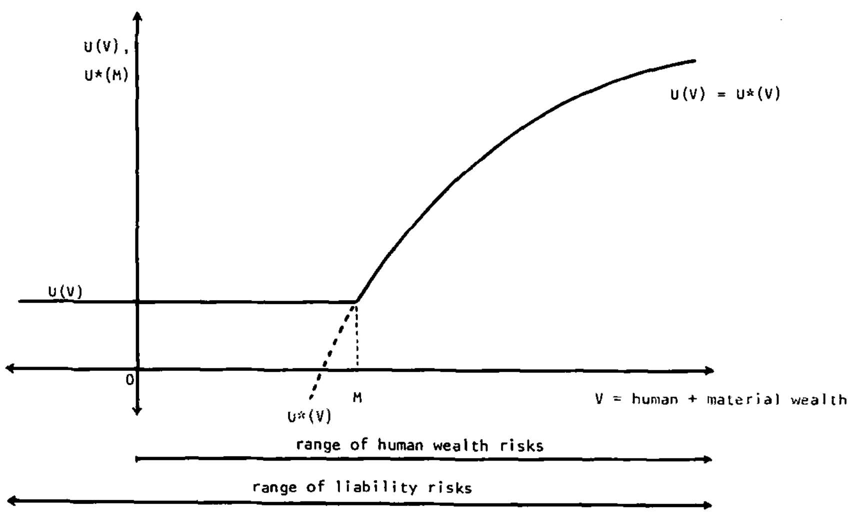

Fig. 1. The kinked utility curve for gross wealth.

3. Full coverage insurance

Suppose that there is a decision-maker with initial wealth A, $A>M$, who faces a given binary[5] loss distribution

[5]The assumption of a binary distribution is here for expositional simplicity only. All basic results have been formulated for arbitrarily-shaped distributions by the author. See Sinn (1980, sect. VC) where, however, an indirect approach to the problem has been taken by first representing the kinked utility function by an equivalent preference structure in a μ, σ diagram. Note that the use of a μ, σ diagram does not imply the usual drawbacks if, as in the present paper, all probability distributions to be compared belong to the same linear class.

$$Y = \begin{pmatrix} 1-w & w \\ 0 & L \end{pmatrix}, \tag{5}$$

and thus the gross wealth distribution

$$V = \begin{pmatrix} 1-w & w \\ A & A-L \end{pmatrix}, \tag{6}$$

where L is a human wealth or liability loss which occurs with probability w. If we offer such a decision-maker a full coverage insurance contract, his maximum willingness to pay for it, P, implicitly is given by

$$U(A-P) = E[U(A-Y)], \tag{7}$$

or explicitly by

$$\begin{aligned} P &= A - S(A-Y) \\ &= A + [E(A-Y) - S(A-Y)] - E(A-Y) \\ &= [E(A-Y) - S(A-Y)] + E(Y), \end{aligned} \tag{8}$$

where $S(\cdot) = U^{-1}[E(\cdot)]$ is the certainty equivalent operator.[6] This result is due to Barrois (1834, p. 260).

It is well known that for globally concave utility functions $E(V) > S(V)$, such that the decision-maker's maximum willingness to pay for the insurance contract exceeds the expected loss, which is the minimum price for which the company will sell the policy. However, in the case at hand the gross wealth utility function is not globally concave, and if L is large enough, it is possible to have a situation where the opposite result holds. This case is illustrated in fig. 2, in which $S(V) > E(V)$. Thus, according to (8), $P < E(Y)$, which indicates that the decision-maker would not, even for a fair premium, be willing to accept the insurance contract.

This striking result casts considerable doubt on whether unregulated insurance markets are appropriate for human wealth and liability risks. Here, the attractiveness of insurance for the potential purchasers might well be inadequate to satisfy the premium requirements of private companies. The reason is that private companies require compensation for the whole risk

[6]For the certainty equivalent to exist we have to require that the utility curve is not horizontal at $E[U(V)]$. For the kinked utility curve which we assume this is always the case if the probability distribution in question has at least one variate above M. In the case at hand this condition is satisfied if $A > M$, as we assumed.

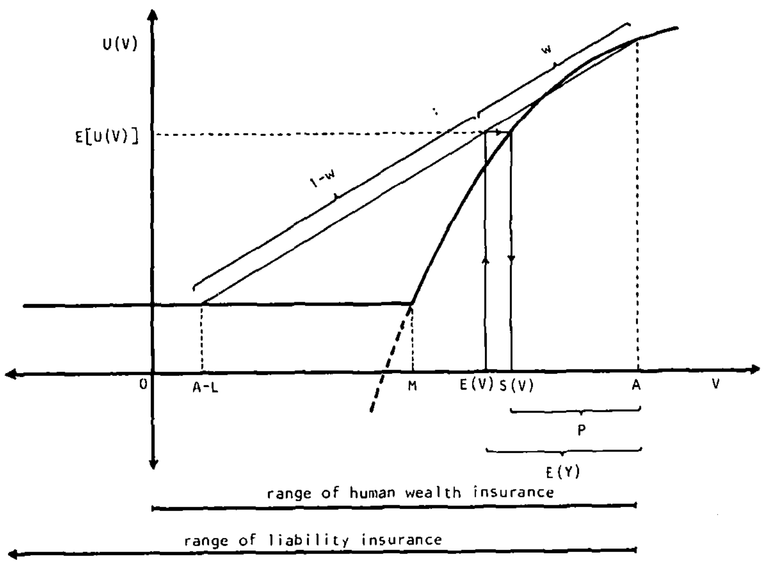

Fig. 2. The maximum willingness to pay for full coverage insurance in the case of human wealth and liability risks.

they insure whereas its customers wish to pay for only that part of the risk they would have to bear without insurance, and not for the other part which, without the purchase of insurance, would be borne by others.

Clearly an unregulated insurance market would be possible in this case if insurance contracts existed which allowed the company to cover only that part of the risk not borne by a third party. However, as we know, such contracts do not exist. It is always the third party which benefits first if an indemnity is paid. If this were not the rule, then we would, in the case of a liability loss, have to observe that the damaged party is not compensated although the insured's wealth is above the socially guaranteed minimum. Similarly, in the case of a loss in human wealth, it would have to be possible to receive welfare payments from the government, although these payments, together with the indemnification of the private company, imply a wealth level above the guaranteed minimum.

The above considerations suggest that unregulated markets for human wealth and liability risks may not work well. However they do not necessarily imply that such markets can never exist. It might be the case that for a considerable number of insurance purchasers we have the unproblematic situation $L<A-M$; and even if we have predominantly the situation where $L>A-M$ it might still be that the maximum willingness to pay exceeds the expected loss. Which of these situations prevails in reality depends on the degree of risk-aversion, the probability of loss, the possible loss, the initial wealth and the guaranteed minimum wealth. The reader may verify easily for himself, with the aid of fig. 2, that the chances of observing $P>E(Y)$, i.e., $S(V)<E(V)$, are the greater,

— the higher the degree of risk aversion as indicated by the extent of the concavity of the utility curve between M and A;
— the lower the probability of loss;
— the lower the possible loss;
— the higher the initial wealth, and
— the lower the guaranteed minimum wealth.

Nevertheless, it seems that the case illustrated in fig. 2 has some empirical relevance. As a matter of fact we observe that many countries have made various types of human wealth and liability insurance compulsory whereas property insurance markets are generally not regulated by government.[7] Obviously politicians are afraid in these countries that the voluntary demand for insurance would be too low. It is in line with this explanation that in some of the United States of America where automobile liability insurance is not compulsory we observe that many people substitute liability insurance with an insurance protecting themselves against damages caused by other drivers.[8]

4. Insurance with variable degrees of coverage

Unlike the previous example we now allow the decision-maker to choose any percentage degree of insurance coverage θ in the range $0 \leqq \theta \leqq 1$, given the premium loading factor required by the company, π. This loading factor is defined such that the premium the purchaser has to pay, if he chooses the degree of coverage θ, is $\pi w \theta L$. We require $1 \leqq \pi < 1/w$, such that the company gets a premium at least equal to the expected loss it insures and, in the case of a damage, the decision-maker is better off with insurance than without.

Under these assumptions the decision-maker faces the binary gross wealth distribution $V = A - \pi w \theta L - Y(1-\theta)$, the variates of which are the 'normal state'

$$v_1 = A - \pi w \theta L, \tag{9}$$

[7]In some countries fire insurance is also compulsory. Probably because there is an implied liability risk in that a fire may destroy more than the insured person's property.

[8]Another example of the low attractiveness of large liability risks can be found in the market for medical malpractice insurance in California. Although this type of insurance was popular for a long time, a large number of practitioners dropped insurance in the early 1970s. The reason was that at that time the courts had begun to increase the rewards for injuries enormously which required a proportionate adjustment in insurance premiums. For decision-makers with strictly concave gross wealth utility functions this phenomenon would not have been observable. This example was suggested to me by Joel Fried.

and the 'damage state'

$$v_2 = A - \pi w\theta L - L(1 - \theta). \tag{10}$$

Given the gross wealth utility function $U(\cdot)$ from (3) he tries to manipulate the gross wealth distribution via a suitable choice of θ such that he achieves the goal

$$\max_{\{\theta\}} E\{U[A - \pi w\theta L - Y(1-\theta)]\} = E\{U[V(\theta)]\}, \tag{11}$$

subject to $0 \leqq \theta \leqq 1$.

In order to understand the nature of this optimization problem, consider the first derivative of $E\{\cdot\}$ with respect to θ,

$$\frac{\partial E\{U[V(\theta)]\}}{\partial \theta} = E\left\{\frac{\partial V(\theta)}{\partial \theta} U'[V(\theta)]\right\}$$

$$= wU'(v_2)L(1-\pi w) - (1-w)U'(v_1)\pi w L. \tag{12}$$

$L(1-\pi w)$ and $-\pi w L$ indicate by how much the loss state and the normal state of wealth change if θ is increased by a unit. Multiplying these changes in the states of wealth by $wU'(v_2)$ and $(1-w)U'(v_1)$ gives the corresponding changes in expected utility.

The solution of the decision-maker's optimization problem for the case of moderate risk, where $L < A - M$, is well known from the study of Mossin (1968). We are interested, however, in the case where $L > A - M$ which may easily occur for human wealth and liability insurance.

Fig. 3 shows a possible graph of the function $E\{U[V(\theta)]\}$ for the case $L > A - M$. A characteristic feature of this graph is that within some initial range, expected utility is a falling function of the degree of coverage. This follows from (12) since $U'(v_2) = 0$ if $v_2 < M$. The explanation is that for sufficiently small values of θ the insurance purchaser does not benefit from an additional unit of protection he buys, but merely lowers the burden which, in the case of damage, has to be borne by others. Only if the insurance purchaser has already bought enough coverage such that $v_2 = M$ will he benefit from an additional unit of coverage. The critical value for the degree of coverage where $v_2 = M$ is from (10) (recall that $L > A - M$ and $\pi < 1/w$ by assumption)

$$\theta^* = \frac{1 - (A - M)/L}{1 - \pi w} > 0, \tag{13}$$

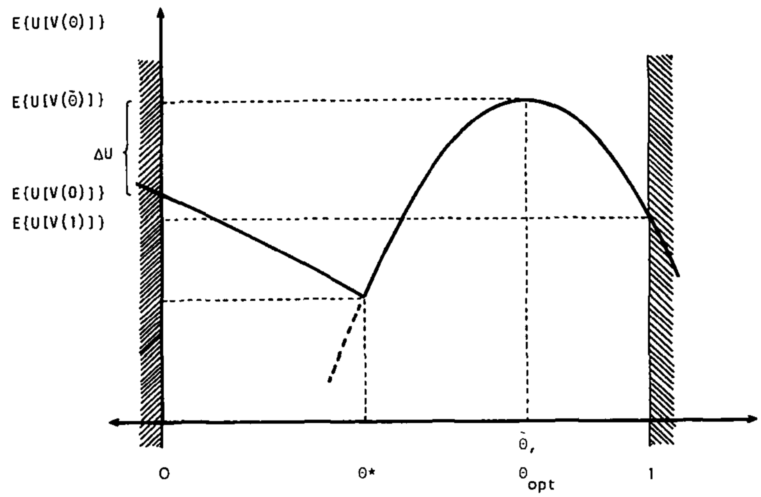

Fig. 3. The optimal degree of coverage in the case of human wealth and liability insurance.

which implies that

$$\theta^*\{\gtreqless\}1 \Leftrightarrow A-\pi wL\{\gtreqless\}M. \tag{14}$$

It is clear that degrees of coverage in the range $0<\theta\leqq\theta^*$ are not optimal. Thus low, yet positive degrees of coverage will never be chosen, if the possible loss is large or the wealth is low enough to render $L>A-M$. This result holds regardless of what premium the insurance company requires. Furthermore, since the admissible range of insurance coverage is $0\leqq\theta\leqq 1$, (14) implies that the optimal degree of coverage is zero whenever insurance is expensive enough such that under full coverage the decision-maker's initial wealth would be reduced to or below the socially guaranteed minimum wealth.

The question is now under what conditions insurance demand occurs provided that $0<\theta^*<1$ and thus $A-\pi wL>M$. We distinguish two different cases in order to find an answer.

The first case is that expected utility is a declining function of the degree of coverage even in the range $\theta^*\leqq\theta\leqq 1$. This situation prevails if within (12) $U'(v_2)$ is, though positive, not large enough to make the expected utility gain from an improvement in the damage state of wealth (v_2) greater than the loss from the deterioration in the normal state (v_1), which is due to the premium increase corresponding to an increase in θ. It can be shown that this must always occur, if in the absence of the guaranteed minimum wealth the optimal degree of coverage would be less than θ^*. Of course, the optimal degree of coverage, taking the guaranteed minimum wealth into account, is zero for this first case.

The second case is that expected utility is a rising function of the degree of coverage in some range above θ^*. Provided that $0<\theta^*<1$ it will always occur if the premium loading factor π is close enough to unity. The reason is that $\pi=1$ implies a local maximum of expected utility at $\theta=1$. The latter becomes evident if we note that

$$\frac{\partial^2 E\{U[V(\theta)]\}}{\partial\theta^2}=\left\{\left(\frac{\partial V(\theta)}{\partial\theta}\right)U''[V(\theta)]\right\}<0 \quad \text{for} \quad \theta>\theta^*, \tag{15}$$

and also that, for $\pi=1$, (12) turns out to be

$$\frac{\partial E\{U[V(\theta)]\}}{\partial\theta}=w(1-w)L[U'(v_2)-U'(v_1)]=0 \quad \text{if} \quad \theta=1$$
$$(\text{i.e., if } v_2=v_1).$$

Whether or not the optimal degree of coverage will be different from zero in this second case is an open question, since obviously there are now two local maxima in the range $0\leqq\theta\leqq 1$. One is at $\theta=0$ and the other anywhere in the region $\theta^*<\theta\leqq 1$. Fig. 3 illustrates this situation under the arbitrary assumption that the local maximum in the region $\theta^*<\theta\leqq 1$ is also a global one.

Some indication of the chance of not finding the global maximum at $\theta=0$ is obtained from a comparison with the full coverage case studied in the previous section. The possibility of partial coverage makes the insurance contract somewhat more favourable for the purchaser and therefore reduces the danger that an unregulated insurance market is not workable for liability and human wealth risks. Suppose we offer the decision-maker the choice between a partial coverage contract, where he can arbitrarily determine θ in the range $0\leqq\theta\leqq 1$, and a full coverage contract, where he can only choose between $\theta=0$ and $\theta=1$. Assume initially that the premium loading factor for both kinds of offers is unity. Then the decision-maker would be indifferent between the two offers since the best local degree of coverage in the range $\theta^*<0\leqq 1$ is unity. So, in this case the above statement is not verified. However, assume now that π is slightly above unity, which is certainly a more realistic case. Then the decision-maker will prefer the partial coverage offer, since the local maximum of expected utility is now at a value of θ smaller than unity. The latter can be proved by setting $\partial E\{U[V(\theta)]\}/\partial\theta=0$ in (12) and then calculating the implicit derivative of θ with respect to π at $\theta=\pi=1$. This derivative turns out to be

$$\frac{\mathrm{d}\theta}{\mathrm{d}\pi}=\frac{U'(A-wL)}{U''(A-wL)L(1-w)}<0. \tag{16}$$

The case of $\pi > 1$ is illustrated in fig. 3. It is apparent from the particular graph of the expected utility function we assumed that the decision-maker might well prefer the optimal degree of coverage in the range $\theta^* < \theta < 1$ to zero coverage, but at the same time prefer zero coverage to full coverage.

Apart from the influence which the kind of contract has on the attractiveness of insurance, the guaranteed minimum wealth, the initial wealth of the purchaser, and the possible loss also seem to be of particular importance. The rôle these parameters play in determining the desirability of a full coverage insurance contract has already been stated above. Corresponding statements for the partial coverage case can easily be derived: denote the locally optimal degree of coverage in the range $\theta^* < \theta \leqq 1$ by $\tilde{\theta}$ and define

$$\Delta U \equiv E\{U[V(\tilde{\theta})]\} - E\{U[V(0)]\}$$
$$= [wU(\tilde{v}_2) + (1-w)U(\tilde{v}_1)] - [wU(M) + (1-w)U(A)], \tag{17}$$

where

$$\tilde{v}_1 \equiv A - \pi w \tilde{\theta} L \quad \text{and} \quad \tilde{v}_2 \equiv A - \pi w \tilde{\theta} L - L(1-\tilde{\theta}).$$

Then you find

$$\frac{\mathrm{d}\Delta U}{\mathrm{d}M} = -wU^{*\prime}(M) < 0, \tag{18}$$

$$\frac{\mathrm{d}\Delta U}{\mathrm{d}A} = (1-w)[U'(\tilde{v}_1) - U'(A)] + wU'(\tilde{v}_2) + \frac{\partial\tilde{\theta}}{\partial A}\frac{\partial E\{U[V(\theta)]\}}{\partial\theta}\bigg|_{\theta=\tilde{\theta}} > 0, \tag{19}$$

$$\frac{\mathrm{d}\Delta U}{\mathrm{d}L} = -\{(1-w)U'(\tilde{v}_1)\pi\tilde{\theta} + wU'(\tilde{v}_2)[1-\tilde{\theta}(1-\pi)]\} + \frac{\partial\tilde{\theta}}{\partial A}\frac{\partial E\{U[V(\theta)]\}}{\partial\theta}\bigg|_{\theta=\tilde{\theta}} < 0, \tag{20}$$

with the signs unambiguously correct if $\theta^* < \tilde{\theta} \leqq 1$ since then $U'(\tilde{v}_1) > U'(A)$, $v_1 \geqq v_2 > M$, and $\partial E\{U[V(\theta)]\}/\partial\theta|_{\theta=\tilde{\theta}} = 0$ by the assumption that $\tilde{\theta}$ characterizes a local maximum. These results are completely compatible with the full coverage case: a decrease in the guaranteed minimum wealth, a reduction of the possible loss and an increase in initial wealth will all increase the attractiveness of a partial coverage insurance offer.

The rôle of wealth should be especially stressed. Consider a decision-maker for whom ΔU is slightly negative such that a zero degree of coverage is optimal. If such a person's wealth is increased we will observe a jump in the desired degree of coverage from zero to $\tilde{\theta}$. In some sense this result is opposite to the negative wealth elasticity of the optimal degree of coverage, which was (correctly) derived by Mossin (1968) for the case of property insurance. The reason for this difference is that Mossin's result is based on the hypothesis that the decision-maker's preferences are characterized by decreasing absolute risk-aversion in the Pratt/Arrow sense whereas our result is due to the guaranteed minimum wealth, an institutional phenomenon.

5. Concluding remarks

In the above analysis we found that the existence of lower boundaries for private wealth is a significant obstacle to the working of unregulated markets for human wealth and liability insurance. Under partial coverage contracts, insurance markets are more likely to exist than under full coverage contracts. But even for partial coverage contracts there is the danger that the attractiveness of insurance is inadequate to offset the premium requirements of the company.

Although it is not our intention to embark upon a detailed discussion of the welfare implications of this result, it is instructive in this context to recall a famous theorem of Borch (1962, p. 428). According to this theorem, in the absence of transaction costs Pareto optimality requires full coverage insurance contracts for risk-averse agents in a large economy.[9] Therefore some welfare loss must be involved if an unregulated insurance market for liability or human wealth risks cannot exist.

One possible way to avoid this welfare loss is to introduce compulsory insurance for human wealth and liability risks, a solution which brings about a net welfare gain if administrative costs are sufficiently low and which is actually chosen by many societies. However, it is not necessary in such cases to require full insurance coverage. It would be sufficient if compulsory coverage were enough to ensure that gross wealth cannot fall below the guaranteed minimum wealth level. As our analysis has demonstrated, beyond this level adequate incentives exist for the voluntary purchase of additional units of coverage.

Since the relevant lower boundary for wealth producing the kink in the utility function usually is a politically determined variable, one could interpret the present study as giving yet another example for the possibility

[9]Borch stated his theorem in a slightly different form for the reinsurance market. Nevertheless the statement in the text is directly implied.

that government intervention causes distortions which then require further intervention. This, however, would only be half of the truth, for even if government would not guarantee a strictly positive minimum wealth there would be a lower boundary for wealth at the level of zero: no one can lose more than he possesses.[10]

With the lowest possible wealth level equal to zero our results would clearly be altered if the utility function were unbounded for $V \to 0$. Some of the special functions frequently used, like $\ln V$ or $-V^{1-\varepsilon}$, $\varepsilon > 1$, or in general, all functions that for $V \to 0$ exhibit relative risk-aversion greater or equal than one, do have this property. However, in the literature two arguments have been advanced against it. One is given by Arrow (1965) with his famous utility-boundedness axiom. The other is presented in Sinn (1980). There, from psychological relativity laws and from axioms ensuring 'specific risk-aversion' an intertemporal preference functional is constructed. The functional implies that the 'myopic' utility function derived from intertemporal optimization exhibits relative risk-aversion smaller than one if, and only if, risk-aversion increases with age. Hence the frequent observation that people become more risk-averse as they grow older suggests that utility is bounded from below. With bounded utility and losses sufficiently large to imply the possibility of negative gross wealth the results of this paper in principle stay valid even if government does not intervene. However, an obvious alteration is that they no longer apply to human wealth risks, but only to liability risks since only here gross wealth can become negative.

For liability risks government regulation does not seem to be avoidable if administrative costs are sufficiently low. Of course there are alternatives to compulsory insurance. For example, one could reintroduce the debtor's prison or some other kind of punishment for those unable to meet their liabilities. But this again would necessitate government intervention and it may well be doubted whether today's societies should really go back to the middle ages.

[10]In Sinn (1980) this is called MAEHKMINN-rule according to the German phrase 'Mehr als er hat, kann man ihm nicht nehmen'.

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