An Experimental comparison of Two Insurance Contracts

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Abstract

We describe the results of an experiment on decision making in an insurance context, with particular reference to two different types of contract format; deductible contracts on the one hand and contracts that provide an upper limit on the possible loss on the other. In particular, using expected utility as the preference function, we consider the optimal amount of insurance purchased under each contract type, the preference of insurance consumers over the two contract types, the incidence of decreasing absolute risk aversion, and the effects of changes in the underlying probability density over losses. We arrive at some conclusions as to the profitability of each contract format for insurers.

1. Introduction

Certainly one of the most influential results in the microeconomics of insurance decisions is the optimality of the deductible format, first proven by Arrow (1963) and Arrow (1971). This result states that, conditional on a non-negative indemnity function and the insurance premium being proportional to the expected value of indemnity payments, all risk averse expected utility maximising insurance consumers will prefer a deductible contract over any other contract format. The robustness of the result was shown by Gollier and Schlesinger (1996), who prove that it holds for any preference function that satisfies second order stochastic dominance. On the other hand, contracts with an upper limit on coverage are also quite common in real-life insurance, and have been shown to have certain optimal characteristics, depending on such things as the insurance cost structure and regulation in the industry (see, for example, Raviv (1979)) and the legal system dealing with bankruptcy issues (Huberman, Mayers and Smith (1983)).

A second interesting result is that, under the theoretically most reasonable type of risk preference, namely decreasing absolute risk aversion, it is impossible to sign the effect on the optimal insurance decision of any given change in the probability density of losses (see, for example, Jang and Hadar (1995)). This is due to the existence of both wealth and substitution effects that work in opposite directions under DARA.

In this paper, we describe an experiment that was carried out with the objective of testing both the dominance of the deductible format, and the effect of changes in the probability density over loss amounts on insurance under two different contract formats. The results presented here are additional to certain other results from the same experimental data, testing the underlying rationality of insurance purchasers, that have been reported in an earlier paper (see Watt, Vázquez and Moreno (2001)).

In particular, for a series of particular hypothetical risk situations, we offered experimental subjects the option of choosing between two different contract formats, a contract with a deductible (a lower limit on the possible loss suffered) and a contract that gives an upper limit to the possible loss suffered. For each risk situation studied, the subjects were asked to choose an optimal coverage for each contract format before choosing between their two optimal contracts. Hence, we are also able to study the effects of parameter changes on optimal insurance for both contract types, which allows us to consider such aspects as the slope of absolute risk aversion, and the effects of changes in probability on coverage.

From our experimental results we are also able to arrive at some general conclusions as to the profitability of different contract formats for the insurer. The upper limit contract is in essence a contract that gives the insurer a deductible, and hence by Arrow's theorem on the optimality of deductible contracts, should be preferred by a risk averse insurer. However, if we assume (as is natural) that the insurer is risk neutral, then he should be indifferent between any two contracts with the same expected value. By considering how much coverage our experimental subjects demand under each contract format for each risk situation considered, we can conclude which contract format gives greater expected profits to a risk neutral insurer.

The paper is structured as follows; in the next section we outline the design and structure of the experiment. In section three we state the particular results that we test with the experimental data, offering a formal proof whenever this exists. Section four presents the results of the experiment, and section five concludes and offers some suggestions as to how the experiment can be of value to the insurance industry.

2. Description of the Experiment

The insurable risks

Participants were shown 10 independent risk situations, with 2 possible insurance options for each. Each risk situation had only two possible outcomes; a large loss, L_1, and a small loss, L_2, such that $L_1 > L_2 \geq 0$. The two possible insurance schemes were, on the one hand, a series of contracts with deductibles, and on the other, contracts with an upper limit on the risk that the individual's possible loss. Both insurance schemes were presented with discrete increments in coverage, between full coverage and no coverage at all, with the corresponding premium clearly indicated. In all cases, the premiums were proportional to the expected value of the indemnity, and in two of the ten situations, the premiums were fair. Subjects were asked to indicate their preferred contract from each of the two insurance schemes, and then to indicate which of the two preferred contracts was their overall preferred choice. The documents that were given to the subjects are included here in the appendix.

The fact that only a discrete set of contracts was offered within each format implies that the particular contract chosen as optimal is, in fact, only optimal within the restricted set of options. There is no reason to conclude that it coincides with the theoretical optimum, and therefore when we consider how a given parameter change affects the optimal insurance decision, we can only arrive at concrete conclusions if the indicated insurance purchase actually varies. That is, if the subject indicates that the parameter change does not affect his insurance purchase, we cannot legitimately conclude that his theoretical optimum has not been affected. In the same way, the discrete nature of the choice set may have certain effects on the optimality of the deductible format. We shall discuss these possible effects together with the relevant experimental results.

The 10 risk situations are set out in Table 11, where p is the probability of the outcome L_2, and λ is the loading factor used for the premiums ($\lambda = 1$ indicates an actuarially fair premium, and $\lambda > 1$ indicates an unfair, or loaded, premium). All the possible losses, and premiums, are expressed in pesetas (10,000 pesetas is approximately $112 NZ).

Table 1 about here

Two different situations are "related" when they differ with respect to only one of the four variables that define them. Choices between any two related situations reveal information regarding the preferences of the subject, and in particular, can be used to study the underlying risk aversion characteristics of the individual.

While the 10 risk situations are related in several different ways, in the present paper we are only interested in situations for which the only difference is the probability of the small loss, and in which the premium is unfair. These are situations 6 and 7 on one hand, and situations 8,9 and 10 on the other. Participants were shown the risk situations in exactly the same order as in Table 1.

Insurance contracts

For each of the ten risk situations, participants were offered two tables of insurance options or "contracts". The first table had deductible contracts, and the second had contracts with an upper limit on the risk faced by the individual. In both cases, the increments in coverage were expressed in steps of 10,000 pesetas ($112 approximately), in order to reduce the number of options that each participant had to consider to a reasonable size. This discrete aspect of the experiment has certain, possibly important, effects on the results, which will be discussed where

1 The experiment was carried out in year 2000, before EURO became the currency in Spain. We present all the results in EURO, nonetheless we decided to keep this table in pesetas (the Spanish former currency) because it reflects the situation as was faced by the participants.

appropriate below.

For each level of coverage (and for each type of contract), the corresponding premium was also clearly stated (also expressed in pesetas). With the exception of the first two situations, the premiums all had a loading factor that was strictly greater than 1. Concretely, denoting a premium by π, and the expected value of indemnity payments by *EV*, the premiums are calculated as follows:

i) deductible contracts (deductible is *d*)

$$VE(d) = kp(L_2 - d) + (1-p)(L_1 - d) \;\; ; \;\; k = 1 \quad if \quad d < L_2 \;\; ; \;\; k = 0 \quad if \quad d \geq L_2$$

$$\pi(d) = \lambda VE(d) .$$

ii) upper limit contracts (coverage limit is *c*)

$$VE(c) = (1-k)\left[pL_2 + (1-p)c \right] + kc \;\; ; \;\; k = 1 \quad if \quad c < L_2 \;\; ; \;\; k = 0 \quad if \quad c \geq L_2$$

$$\pi(c) = \lambda VE(c) .$$

Participants and incentives

The subjects that participated in the experiment were all undergraduate students of economics at the Universidad Autónoma de Madrid. Two groups of students participated in the experiment. Both groups had been taught introductory microeconomic theory (including uncertainty), but had not seen (in class) any material directly related to optimal insurance decisions. In order that the participants had a direct incentive to answer the experiment seriously, it was announced that the participant whose answers displayed “the most consistency and rationality” would win a monetary prize of 200,000 pesetas (approximately $2,187 NZ). The first group of students (in what follows, “group 1”) answered the experiment in class time (about an hour), while the second group (“group 2”) took the experiment home and handed their answers in the next day. Of those that took the questionaire home, a considerable number of participants did not hand in their answers, hence group 1 outnumbered group 2, although more participants were initially given the questionaire in the second group than in the first.

Aside from the usual considerations for using students as experimental subjects (low cost, availability, etc.), it was hoped that students would understand the questions in the experiment fully, above all, the notion of probability. We found that certain other individuals, while real-life insurance consumers, did not properly understand the notion of probability. In any case, in the instructions that accompanied the experiment, the notion of probability was clearly explained (in each risk situation, the probabilities sere expressed in percentage terms, which we found enhanced the understanding of the situation), as were the implications of each type of contract (see appendix 1). Furthermore, Schoemaker and Kunreuther (1979) find that students and real insurance clients do not differ substantially in insurance decisions, hence our subjects are likely to be representative of a far wider group of insurance consumers.

3. Some Theoretically Expected Results

If we base our expectations of rational behaviour on the expected utility hypothesis (see Von Neumann and Morgenstern (1944)), then we can use the results of the experiment questionnaires to consider several important aspects of the demand for insurance. To do so, we only assume that the experiment subject has a utility function for money of $u(x)$, which is assumed to be strictly increasing at all wealth levels, $u'(x) > 0$, that the second and third derivatives of the utility function have constant sign, and that the individual possesses some strictly positive amount of wealth, w, that is independent of the wealth at risk. The results that are given here are all well known from the existing insurance literature, although in the interests of completeness, a formal proof of each is given. The final result cannot be proved, and for this reason we refer to it as a “hypothesis” rather than a “result”. It will, however, be tested with the experimental data. Throughout, the reader is reminded that the optimal decision when a deductible contract format is considered is denoted by d^*, while the optimal decision when an upper limit contract format is considered is denoted by c^*.

Results concerning deductible contracts

For deductible contracts, the premium can be expressed as:

$$\pi(\lambda, d) = \begin{cases} \lambda\left[pL_2 + (1-p)L_1 - d\right] & d \leq L_2 \\ \lambda(1-p)(L_1 - d) & L_2 < d < L_1 \\ 0 & d \geq L_1 \end{cases} \tag{1}$$

and expected utility is:

$$EU(d) = \begin{cases} u(w - \pi(d) - d) & d \leq L_2 \\ pu(w - \pi(d) - L_2) + (1-p)u(w - \pi(d) - d) & L_2 < d < L_1 \\ pu(w - L_2) + (1-p)u(w - L_1) & d \geq L_1 \end{cases} \tag{2}$$

Result 1: Assuming $\lambda > 1$, the optimal deductible will always satisfy $d^* > L_2$.

Proof: From (1), for all $d \le L_2$, we have:

$$\frac{\partial \pi}{\partial d} = -\lambda \tag{3}$$

Marginal expected utility in this case is:

$$u'(w-\pi(\lambda,d)-d)\left(-\frac{\partial \pi}{\partial d}-1\right) = -u'(w-\pi(\lambda,d)-d)(1-\lambda)$$

which is necessarily positive under the assumption of positive marginal utility, since $\lambda > 1$. Therefore expected utility is increasing for all deductible values less than or equal to the small loss, implying that no such deductible can ever be optimal.

Q.E.D.

We shall refer to a choice that is consistent with result 1 an "internal optimum". Given result 1, we now consider contracts with a deductible that satisfies $L_2 < d < L_1$. For such contracts, the marginal premium is:

$$\frac{\partial \pi}{\partial d} = -\lambda(1-p) \tag{4}$$

The marginal utility of such a contract is given by:

$$EU'(d) = (1-p)\left[pu'(a)\lambda - u'(b)(1-\lambda(1-p))\right] \tag{5}$$

where:

$$a \equiv w-\lambda(1-p)(L_1-d)-L_2 \qquad b \equiv w-\lambda(1-p)(L_1-d)-d$$

Since we are assuming $d > L_2$, it holds that $a > b$.

Result 2: Assuming $\lambda > 1$, if the optimal deductible is less than the large loss value, that is, $d^* < L_1$, then the individual must be risk averse, i.e. $u''(x) < 0$.

Proof: Assume that the individual is either risk neutral or risk loving, i.e. $u''(x) \ge 0$. Since $a > b$, we would have $u'(a) \ge u'(b)$. Hence, in this case the first derivative of expected utility satisfies:

$$EU'(d) \ge (1-p)u'(b)\left[p\lambda - (1-\lambda(1-p)\right] = (1-p)u'(b)(\lambda-1) > 0$$

In this case, the optimal solution is to set the deductible equal to the large loss, that is, no insurance is purchased.

Given that an internal solution is inconsistent with either risk neutral or risk loving preferences, and the assumption that the second derivative of utility has monotone slope, the only option that can admit an internal solution, that is $d^* < L_1$, is a concave utility function, $u''(x) < 0$.

Q.E.D

Given an internal solution, the second derivative of expected utility is:

$$EU''(d) = pu''(a)(\lambda(1-p))^2 + (1-p)u''(b)(\lambda(1-p)-1)^2 < 0$$

hence the first order condition for an optimum in this case is given by $EU'(d^*) = 0$. Define

$$h(p,\lambda,L_1,L_2,d^*) \equiv \lambda pu'(a^*) - u'(b^*)(1-\lambda(1-p)) \tag{6}$$

so that the first order condition is where $h(\cdot)$=0, or:

$$\lambda = \frac{u'(b^*)}{pu'(a^*)+(1-p)u'(b^*)} \tag{7}$$

We now go on to consider the effects of changes in the underlying parameters on the optimal deductible, assuming risk aversion, loaded premiums and situations that are consistent with result 1 (i.e., situations with internal optimums). To do so, we make use of the implicit function theorem, which can be stated as:

$$\frac{\partial d^*}{\partial y} = -\frac{\left(\dfrac{\partial^2 EU}{\partial d^* \partial y}\right)}{\left(\dfrac{\partial^2 EU}{\partial d^{*2}}\right)} \tag{8}$$

where y can be any of the parameters λ, p, L_1 and L_2. Since, given risk aversion, expected utility is strictly concave in the optimal deductible, (8) indicates that the sign of the effect of the change in the parameter on the optimal deductible is the same as the sign of the cross derivative of expected utility (the numerator of (8)). However, the sign of this cross derivative is equal to the sign of $\partial h/\partial y$.

The following corollary will also be useful throughout some of the next results:

Corollary 1: If the utility function displays decreasing (increasing) absolute risk aversion, then:

$$u''(b^*) < (>)\, \lambda(pu''(a^*)+(1-p)u''(b^*)) \tag{9}$$

Proof: Using (7), equation (9) can be written as:

$$u''(b^*)(pu'(a^*)+(1-p)u'(b^*)) < (>)\, u'(b^*)(pu''(a^*)+(1-p)u''(b^*))$$

Subtracting $(1-p)u'(b^*)u''(b^*)$ from each side, and dividing by p yields:

$$u''(b^*)u'(a^*) < (>)\, u'(b^*)u''(a^*)$$

which rearranges directly to:

$$-\frac{u''(b^*)}{u'(b^*)} > (<) -\frac{u''(a^*)}{u'(a^*)}$$

Finally, recalling that $a^* > b^*$, we have decreasing (increasing) absolute risk aversion.

Q.E.D.

Of course, under constant absolute risk aversion (9) would hold with equality. However, as was noted above, given the fact that subjects in the experiment were not given a continuous choice of insurance contracts, an individual that does not alter his optimal choices of deductible does not reveal information as to his true underlying risk preference.

Result 3: If the individual is risk averse, and if $\lambda > 1$, then if an increase in the large loss L_1 has the effect of decreasing (increasing) the optimal deductible for a risk averse subject, then the utility function satisfies decreasing (increasing) absolute risk aversion.

Proof: If an increase in L_1 has the effect of decreasing (increasing) the optimal deductible, then it must hold that:

$$\frac{\partial h}{\partial L_1} < (>) 0$$

From (6):

$$\frac{\partial h}{\partial L_1} = -\lambda(1-p)\left[\lambda p u''(a^*) - (1-\lambda(1-p))u''(b^*)\right]$$

Hence:

$$\frac{\partial h}{\partial L_1} < (>)\ 0 \quad \text{as} \quad \lambda p u''(a^*) - (1-\lambda(1-p))u''(b^*) > (<)\ 0$$

that is:

$$\frac{\partial h}{\partial L_1} < (>)\ 0 \quad \text{as} \quad \lambda\left[p u''(a^*) + (1-p)u''(b^*)\right] > (<) u''(b^*)$$

Hence, from corollary 1, it holds that the utility function displays DARA (IARA).

Q.E.D.

Results concerning upper limit contracts

For upper limit contracts, the premium can be expressed as:

$$\pi(\lambda, c) = \begin{cases} \lambda c & c \le L_2 \\ \lambda\left[pL_2 + (1-p)c\right] & L_2 < c < L_1 \\ \lambda\left[pL_2 + (1-p)L_1\right] & c \ge L_1 \end{cases} \tag{10}$$

and the expected utility is:

$$EU(c) = \begin{cases} pu(w-\pi(c)-L_2+c)+(1-p)u(w-\pi(c)-L_1+c) & c \le L_2 \\ pu(w-\pi(c))+(1-p)u(w-\pi(c)-L_1+c) & L_2 < c < L_1 \\ u(w-\pi(c)) & c \ge L_1 \end{cases} \tag{11}$$

Result 4: No interior solution with $0 < c \le L_2$ exists if $\lambda > 1$.

Proof: Marginal utility with $c \le L_2$ is:

$$EU'(c) = -\left(pu'(w-\lambda c-L_2+c)+(1-p)u'(w-\lambda c-L_1+c)\right)(\lambda-1)$$

which, with $\lambda > 1$, is strictly negative, implying that *c*=0 gives greater expected utility than any other value of *c* that satisfies $0 < c \le L_2$.

Q.E.D.

As for deductible contracts, we say that an upper limit contract choice that is consistent with result 4 is an "internal optimum". Now consider contracts such that $c \ge L_2$, for which marginal expected utility is:

$$EU'(c) = (1-p)\left[-\lambda pu'(a) + (1-\lambda(1-p))u'(b)\right] \tag{12}$$

where:

$$a \equiv w - \lambda(pL_2 + (1-p)c) \qquad b \equiv w - \lambda(pL_2 + (1-p)c) - L_1 + c$$

Note that since $c < L_1$, it holds that $a > b$.

Result 5: If $\lambda > 1$, and the optimal coverage satisfies $c^* > L_2$, then the subject is risk averse, i.e. $u''(x) < 0$.

Proof: Assume that the individual is either risk neutral or risk loving, so that $u''(x) \ge 0$. Since $a > b$, we would have $u'(a) \ge u'(b)$. In this case, marginal utility (equation (12)) satisfies:

$$EU'(c) \le (1-p)u'(a)\left[-\lambda p + (1-\lambda(1-p)\right] = (1-p)u'(a)(1-\lambda) < 0$$

Hence the expected utility of risk neutral or risk loving subjects has negative slope over the range $L_2 < c < L_1$. Together with result 4 the implication is that for these individuals $c^* = 0$, i.e. no coverage is purchased.

Since an interior solution cannot be supported by risk neutral or risk loving preferences, it can only correspond to risk averse preferences.

Q.E.D.

If utility is concave, then:

$$EU''(c) = (-\lambda(1-p))^2 pu''(a) + (1-\lambda(1-p))^2(1-p)u''(b) < 0$$

in which case the first order condition for an optimal solution is:

$$g(L_1, L_2, p, \lambda) \equiv -\lambda pu'(a^*) + (1-\lambda(1-p))u'(b^*) = 0 \qquad (13)$$

Given (13), we can directly state that, any interior solution must satisfy equation (7), with the relevant substitutions for a^* and b^*.

Result 6: If the individual is risk averse, and if $\lambda > 1$, then if an increase in the small loss has the effect of increasing (decreasing) the optimal coverage, then the utility function displays decreasing (increasing) absolute risk aversion.

Proof: If an increase in L_2 increases (decreases) the optimal coverage, then it must hold that:

$$\frac{\partial g}{\partial L_2} > (<)\ 0$$

However:

$$\frac{\partial g}{\partial L_2} = -\lambda p\left[-\lambda pu''\left(a^*\right) + \left(1-\lambda\left(1-p\right)\right)u''(b^*)\right]$$

Hence:

$$\frac{\partial g}{\partial L_2} > (<) 0 \quad \text{as} \quad -\lambda pu''(a^*) + (1-\lambda(1-p))u''(b^*) < (>) 0$$

That is:

$$\frac{\partial g}{\partial L_2} > (<) 0 \quad \text{as} \quad u''(b^*) < (>)\ \lambda\left[pu''(a^*) + (1-p)u''(b^*)\right]$$

Therefore, from corollary 1, we have DARA (IARA).

Q.E.D.

General Results

Result 7: The optimal deductible contract is preferred to the optimal upper limit contract.

Proof: A general proof is given in Gollier and Schlessinger (1996).

Q.E.D.

Result 7 states that when asked to indicate the preference between the chosen optimal deductible contract and the optimal upper limit coverage contract, risk averse individuals should select the former. We cannot expect that the frequency of preference for the optimal deductible contract be absolute, since it may turn out that the theoretically optimal deductible contract is no among those offered, and the best upper limit contract of those offered may be preferred to the best deductible contract of those offered. However, we do expect that at least the frequency of preference for the deductible format to be greater than that of the upper limit coverage format.

Result 8: If the insurance consumer's utility function satisfies DARA (IARA), then it holds that $c^* - L_2 > (<)\, L_1 - d^*$.

Proof: The expected utility of any interior deductible contract is:

$$EU_d(w,p,d) = pu(w - \pi_d(p,d) - L_2) + (1-p)u(w - \pi_d(p,d) - d) \tag{14}$$

where $\pi_d(p,d) = \lambda(1-p)(L_1 - d)$, and the expected utility of any interior upper limit contract is:

$$EU_c(w,p,c) = pu(w - \pi_c(p,c)) + (1-p)u(w - \pi_c(p,c) - L_1 + c)$$

where $\pi_c(p,c) = \lambda(pL_2 + (1-p)c)$. Simple substitutions now reveal that:

$$EU_c(w + (\lambda - 1)L_2, p, L_1 + L_2 - d) = EU_d(w,p,d) \tag{15}$$

and:

$$EU_c(w,p,c) = EU_d(w - (\lambda - 1)L_2, p, L_1 + L_2 - c) \tag{16}$$

Therefore, from (14):

$$\frac{\partial EU_d(w,p,d)}{\partial d} = pu'(a)(\lambda(1-p)) + (1-p)u'(b)(\lambda(1-p) - 1)$$

where $a \equiv w - \pi_d(p,d) - L_2$ and $b \equiv w - \pi_d(p,d) - d$. Hence:

$$\frac{\partial^2 EU_d(w,p,d)}{\partial d \partial w} = (1-p)(p\lambda u''(a) - (1 - \lambda(1-p))u''(b)) \tag{17}$$

From corollary 1, under DARA equation (17) is positive, while under IARA it is negative.

Assuming DARA, we know that the optimum upper limit coverage contract satisfies the first order condition that the first derivative of $EU_c(\cdot)$ with respect to *c* goes to 0. Hence, using equation (16), and the fact that as we have just shown, under DARA the marginal expected utility of the optimal deductible is increasing in wealth (and recalling that $w-(\lambda-1)L_2 < w$), we have:

$$0=\frac{\partial EU_c(w,p,c^*)}{\partial c}=-\frac{\partial EU_d(w-(\lambda-1)L_2,p,L_1+L_2-c^*)}{\partial d}>-\frac{\partial EU_d(w,p,L_1+L_2-c^*)}{\partial d}$$

Finally, since $EU_d(\cdot)$ is strictly concave in *d*, and since as we have just shown, it holds that its slope is strictly positive at $d=L_1+L_2-c^*$, it must be true that $d^*>L_1+L_2-c^*$, which rearranges directly to $c^*-L_2>L_1-d^*$. The reverse argument (using equation (15)) shows that under IARA it holds that $c^*-L_2<L_1-d^*$.

Q.E.D.

Note that the coverage purchased under a deductible contract is L_1-d, while the coverage purchased under an upper limit contract is $c-L_2$. Therefore, for any given value of L_1-L_2, result 8 states that, in their optimum, insurance consumers will purchase less (more) coverage under the deductible contract format than under the upper limit contract format if the utility function satisfies DARA (IARA).

Hypothesis 1: An increase in the probability of the small loss results in the same effect on coverage under both contract formats, i.e. $\left(\frac{\partial(c^*-L_2)}{\partial p}\right)\left(\frac{\partial(L_1-d^*)}{\partial p}\right)>0$.

Hypothesis 1 cannot be proved in general. It does, however, hold for sure under IARA. However, since we are most interested in DARA preferences, for which hypothesis 1 cannot be proven, no proof is supplied. In any case, the hypothesis seems to be quite logical, since it says that, independently of the slope of absolute risk aversion, a change in the density of the loss variable should have the same final effect on the amount of risk that is to be retained under both contract formats.

Of course, for given values of the two loss variables, hypothesis 1 can be expressed more simply as:

$$\left(\frac{\partial c^*}{\partial p}\right)\left(\frac{\partial d^*}{\partial p}\right)<0$$

Result 9: Assuming the same loading factor for either contract format, $\lambda>1$, the contract with the highest premium gives the highest expected profit to the insurer.

Proof: Independent of contract format, the premium is given by $\pi = \lambda EV(I)$, where $EV(I)$ is the expected value of the indemnity, and the expected profit from any contract is given by $E\Pi = \pi - EV(I) = EV(I)(\lambda - 1)$. Direct substitution then reveals that:

$$E\Pi = \pi\left(\frac{\lambda - 1}{\lambda}\right)$$

Q.E.D.

4. Experimental results

In this section we describe the relevant results of the experiment. The data is presented mainly in tables, although some graphs are also shown. In the interests of simplicity, here we shall refer to the deductible contracts as *d*-contracts, and the upper limit coverage contracts as *c*-contracts.

To begin with, we summarise the results of the experiment in Table 2 (shows the average choice of contract over both of the two groups of students, together with the frequency with which respondents indicated risk aversion, i.e. a deductible strictly less than the large loss, and an upper limit coverage that is strictly greater than the small loss). The information in Table 2 is also shown graphically in Figures 1 to 6.

Table 2 about here

Figures 1 to 6 about here

As can be seen by the bar-graphs of the frequencies with which respondents gave solutions with positive coverage on risk situations 3 to 10 (by results 2 and 5) over all they show a very high degree of risk aversion. A second interesting aspect of the results of the experiment is immediately obvious from the bar-graphs of the frequencies of solutions with positive coverage. For both groups of respondents, it holds for almost all risk situations that the frequency of responses consistent with risk aversion is greater for *d*-contracts than for *c*-contracts. This can be stated more clearly as, for almost all risk situations, no-coverage being purchased is somewhat more common for *c*-contracts than for *d*-contracts. Indeed, since the only risk situations in which there is a higher frequency of risk averse responses under the *c*-contract format are situations 1, 3 and 4, we can state that on this experiment, people always showed a lower frequency of risk averse responses on *c*-contracts than on *d*-contracts whenever the small loss was strictly positive.

The dominance of the d-contract format

From Table 2, we can validly conclude that, over all, our subjects are risk averse (indeed, only one respondent - respondent 2 in group 2 - cannot be considered to be risk averse. This respondent was eliminated from all successive analysis), and hence it is valid to use the experiment to test Arrow's theorem of the dominance of the deductible contract. As we state in result 7, given actuarially unfair premiums (risk situations 3 to 10), risk averse individuals should always have a preference for the deductible contract format over all others, including logically, the *c*-contract format proposed here. Naturally, given the discrete nature of the choices that we offered our subjects, we should not expect that the dominance of the deductible contract format to be absolute (the choices shown as optimal may be the closest to each of the theoretical optimums, and yet it is entirely possible that the *c*-contract chosen is closer to the theoretical optimum than is the *d*-contract chosen). However, we do expect that second order rational respondents would show a greater frequency of preference for the *d*-contract chosen for each risk situation above the chosen *c*-contract.

In group 1, there is an average incidence of 23% (140 out of 616 possible responses) of respondents indicating a strict preference for the *c*-contract over the *d*-contract, while in group 2 the incidence is 41% (182 out of 448 possible responses). Over the two groups, we have an aggregate incidence of this type of second order irrationality of 30%. That is, close to a third of all of the preference choices of all individuals over all risk situations display a strict preference for the *c*-contract format over the *d*-contract format, in contradiction to Arrow's theorem.

Exactly how strong this result is depends entirely on how important it is that the set of contract choices for both contract formats is discrete. As noted above, the discrete nature of the contracts on offer implies that, even though there is a strict preference for the "optimal" *d*-contract over the "optimal" *c*-contract, the preference over the optimal contracts contained in the choice set may be reversed. Hence, there may be some respondents included in the above statistic that, theoretically, should not be. On the other hand, it is also inconsistent with the theorem that, given strict risk aversion, the two contract formats are equally preferred. However, all respondents that were indifferent between their two optimal contracts were not included in the above statistics, since given the discrete nature of the choice set, these responses do not constitute a strict violation of Arrow's theorem. Which of these two effects is greater is unknown and unknowable, although we suspect that both are of minimal importance to the final statistic.

Results concerning the slope of absolute risk aversion

Depending upon how a respondent's *d*-contract choice responds to an increase in the large loss, and how his *c*-contract choice responds to an increase in the small loss, he manifests the slope of his absolute risk aversion function (assuming he is risk averse - hence only respondent 2 of group 2 has been eliminated). The relevant results are reported in Tables 3.1 and 3.2, where "D" represents an answer that reveals decreasing absolute risk aversion, and "I" represents an answer that reveals increasing absolute risk aversion. Due to the discrete nature of the questions, we cannot conclude that a respondent who does not alter his responses necessarily satisfies constant absolute risk aversion, and so these answers are simply indicated by a "---" in the table, since such an answer is not directly inconsistent with either decreasing or increasing absolute risk aversion. Furthermore, in order for the direction of the change in the optimal insurance decision to reflect the slope of absolute risk aversion, it must also hold that the solutions are internal. Any respondent who's insurance purchase is not internal (or indeed, is not given) on any given choice is simply indicated by NA (not applicable) in the tables.

In group 1 (Table 3.1), on the *d*-contract test, a very high proportion of respondents show decreasing absolute risk aversion. In total, out of 77 respondents, 65 showed DARA (84.42%), 6 showed IARA (7.79%), and the other 6 (7.79%) were either not internal solutions or who showed no change in optimal deductible over risk situations 5 and 6. Similar results are found in group 2's *d*-contract test (Table 3.2), where out of 56 respondents (recall, respondent 2 was eliminated for not being risk averse), 40 showed DARA (71.43%), 1 showed IARA (1.79%), and the other 15 (26.78%) were either not internal solutions or showed no change in optimal deductible over risk situations 5 and 6.

Curiously, DARA is far less frequent than IARA when *c*-contract decisions are considered. In group 1, for the three *c*-contract tests of the slope of risk aversion, the frequencies of DARA were only 27.27%, 35.06% and 40.26%. The respective frequencies of IARA on the same questions were 40.26%, 35.06% and 33.77%. It is interesting to note that, for group 1 when the *c*-contract tests for the slope of risk aversion are made, the frequencies of DARA, IARA and others are very similar. Once again, the results of the same test in group 2 is very similar, with the following DARA frequencies 35.71%, 32.14% and 32.14%, and IARA frequencies of

30.36%, 33.93% and 30.36%.

As a general conclusion to tables 3.1 and 3.2, we can say that:

i. DARA is markedly more frequent under *d*-contracts than under *c*-contracts,

ii. the incidence of answers that show either no change of insurance strategy or a non-internal optimum, is far greater under *c*-contracts than under *d*-contracts,

iii. under *c*-contracts, the incidence of DARA is almost the same as the incidence of IARA.

The question remains; overall, are people more DARA or more IARA? To attempt to answer that question, we consider the aggregate average choice of coverage (from Table 2) together with result 8. The results of this analysis are shown in Table 4 (only risk situations with positive loading are considered, i.e. situations 3-10). Recall that under IARA the sum of the two contract choices should be less than the sum of the two possible losses, while under DARA the opposite is true. We note that the former relationship holds in aggregate for both groups and for all risk situations with the exception of group 1 risk situation 4. Hence, contrary to what is commonly thought, it seems reasonable to conclude that IARA is in fact more predominant than DARA.

We now consider the effect of an increase in the probability of the small loss on the optimal insurance decision. As is well known (see, for example, Jang and Hadar (1995) for a discrete model quite risk situations in our experiment), the effect of a change in probability on the optimal insurance decision is ambiguous under DARA, since it implies both a substitution and a wealth effect that work in opposite directions. Given the high incidence of DARA consistent answers on *d*-contracts, we are especially interested in how an increase in the probability of the small loss affected the optimal deductible. For the IARA case, the same increase in probability should (theoretically) increase the demand for coverage. Concretely, an increase in the probability of the small loss is tested with risk situations 3 and 4 on one hand, and situations 8, 9 and 10 on the other.

Here we shall only report on the summary of the results of an increase in probability of the small loss (p). These results are shown in table 5. In group 1, an increase in p had the effect of decreasing the average optimal deductible over situations 8 and 9, and increasing it on situations 3 and 4, 6 and 7, 9 and 10, and 8 and 10. On the other hand, in group 2, the effect was positive over situations 3 and 4, 6 and 7 and situations 8 and 9, and negative on the other two. Hence, the sign of the effect of an increase in p on the optimal deductible coincides over the two groups for situations 3 and 4 and situations 6 and 7 (positive) only, and there is no consensus as to what sign the effect seems to take in general. For both groups, the standard deviations of the effect of the increases in *p* are relatively high.

As far as *c*-contracts are concerned, the two groups coincide in the sign of the effect of an increase in *p* on all situations, although this effect is negative over situations 3 and 4, situations 6 and 7, situations 9 and 10, and situations 8 and 10, but positive over situations 8 and 9. The absolute size of each of the standard deviations are, once again, rather large. As for the case of deductible contracts, the effect of an increase in the probability of the small loss was not uniform in the experiment.

In tables 6.1 and 6.2, we show the sign of the product of the changes in optimal insurance purchase when the probability of the low loss increases. From hypothesis 1, we expect this product would be negative. In the tables, "0" indicates that at least one of the optimal insurance decisions did not change, and "NA" represents almost always that on at least one of the two relevant situations a non-interior solution was given (in very limited number of questionaires, no some situations were left unanswered. These are also indicated by "NA" in tables 6.1 and 6.2).

In both groups, we find limited evidence that supports hypothesis 1. For all of the comparisons, the number of answers supporting the hypothesis (in the tables, a negative sign) outnumber significantly the number of answers that are in direct contradiction to the hypothesis (a positive sign). The exception is situations 8 and 9 in group 2. Overall, we should also point out that the number of answers that are inconsistent with an internal solution are worryingly high (see Watt, Vázquez and Moreno (2001) for a discussion of certain results from the experiment concerning irrationality).

Our final results concerning the comparison of the two contract formats that were used in the experiment are regarding the profitability of each contract format for insurers. As is noted in result 9, the higher is the premium corresponding to the contract indicated, the higher is the expected profit for a risk neutral insurer (assuming a loading factor greater than 1). In table 7 we report the average premium corresponding to each of the two contract formats on the 8 situations for which the loading factor was greater than 1, for the two groups of subjects, together with the standard deviation. As can be seen in the table, in group 1, the average premium on *c*-contracts is greater than the average premium on *d*-contracts for all situations except situation 3 (and in some cases, it is significantly higher). Hence, for this group, the insurer would have earned greater profits from the *c*-contract format than from the *d*-contract format. The situation is very similar for group 2, where the *c*-contract format is more profitable to the insurer on all risk situations except for situations 3 and 4. Overall, we conclude that the experiment supports the statement that *c*-contract formats are more profitable to risk neutral insurers than *d*-contract formats.

6 Conclusions

In this paper, we have reported on the results of an experiment designed to compare two different insurance contract formats, both of which have been the object of study in the insurance literature, on one hand, contracts with full coverage above a deductible (*d*-contracts), and on the other, contracts with an upper limit on coverage (*c*-contracts). In the experiment, aside from other minor results, we consider Arrow's theorem concerning the optimality of the deductible format, and the slope of the Arrow-Pratt measure of absolute risk aversion under each contract type. In particular, we have studied the effects of a change in the underlying loss probability density function.

Firstly, we noted that contracts with no-coverage are generally (although only slightly) more frequent under *c*-contracts than under *d*-contracts. This trend, however, was unanimous (in the aggregate) on all risk situations with a strictly positive small loss. This does not mean that, overall, *c*-contracts imply lower average coverage than *d*-contracts. As we showed in our theoretical results section, this depends on the slope of absolute risk aversion.

We find that about two thirds of all of the answers given are in agreement with Arrow's dominance of deductible theorem. This result, however, is at best an approximation of the true degree of compliance with the theorem due to the discrete nature of the set of choices of contracts. On one hand, the true degree of responses that are inconsistent with the theorem would be higher since responses that did not constitute a strong violation were not counted. On the other hand, the fact that one can expect that since some upper limit contracts chosen may be closer to the theoretical optimum than the chosen deductible contract, some of the responses that are (apparently) violations of the theorem, are in fact not violations. However, we expect both of these effects, which work in opposite directions, to be small.

As far as our results concerning the slope of the Arrow-Pratt measure of absolute risk aversion, we find that DARA is much more predominant under *d*-contracts than under *c*-contracts, although there is no theoretical reason why this should be so. However, this result from our experimental data opens the natural question of whether our subjects were predominantly DARA or IARA. Using the aggregate data, taking into account both contract formats, the fact that the sum of the two average insurance purchases on almost all risk situations is generally less than the sum of the two possible losses suggests that IARA is more predominant than DARA, contrary to what traditional wisdom suggests.

Using our experimental data, we cannot generate a general conclusion regarding the effect of an increase in the probability of the small loss on optimal contracts (and coverage). While this is a rather negative result, it is in line with the traditional theory, which states that, under DARA, the effect is ambiguous. Since some of our respondents are DARA, their presence may be what makes our experimental data ambiguous as well.

On the other hand, the experiment does provide limited support for hypothesis 1, that is, an increase in the probability of the small loss has effects on optimal coverage of the same sign under both contract types.

Finally, we are able to use our experiment to consider the profitability of each of the two contract formats for insurers. The experiment supports the conclusion that the *c*-contract format is generally more profitable than the *d*-contract format.

Naturally, all of the results that our experiment tests are conditioned by the underlying assumptions, for example expected utility, and the monotonicity assumption placed on the derivatives of the utility function. It is well known that experimental evidence is not very supportive of the expected utility assumption (see, for a very recent example, Sopher and Narramore (2000)), upon which our expected results are based. However, at least one of our results does not depend on expected utility (the dominance of the deductible contract format), and it is very likely that all our first and second order rationality tests can also be cast in terms of first and second order stochastic dominance also, thereby admitting a far wider range of preference functions.

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Table 1 - The 10 Risk Situations

Situation	L_1	L_2	p	
1	140,000	0	0.8	1
2	140,000	20,000	0.8	1
3	70,000	0	0.7	1.1
4	70,000	0	0.9	1.1
5	70,000	10,000	0.7	1.1
6	140,000	10,000	0.7	1.1
7	140,000	10,000	0.8	1.1
8	140,000	20,000	0.8	1.1
9	140,000	20,000	0.7	1.1
10	140,000	20,000	0.9	1.1

Table 2. Summary of Experimental results (c and d data is actual number EURO)

situation	1	2	3	4	5	6	7	8	9	10
G1 average c	355.14	371.53	198.49	124.16	181.08	373.10	327.82	330.17	366.07	305.19
G2 average c	350.06	347.95	198.23	149.73	192.96	384.86	364.82	321.97	369.04	308.94
G1 average d	489.40	387.15	219.84	302.88	221.67	413.68	490.18	418.37	414.46	409.78
G2 average d	400.67	362.72	192.96	229.86	178.19	376.71	372.21	353.09	382.75	317.38
G1 freq. $d<L_1$	0.96	0.99	1.00	0.79	1.00	0.99	0.99	0.99	1.00	1.00
G2 freq. $d<L_1$	0.95	0.96	0.93	0.81	0.96	0.95	0.95	0.95	0.95	0.95
G1 freq. $c>L_2$	0.99	0.86	0.99	0.84	0.84	0.91	0.90	0.87	0.87	0.69
G2 freq. $c>L_2$	0.95	0.82	0.95	0.75	0.81	0.89	0.86	0.72	0.88	0.70

Figure 1: Group 1 Average Insurance Purchase, *c*-contracts

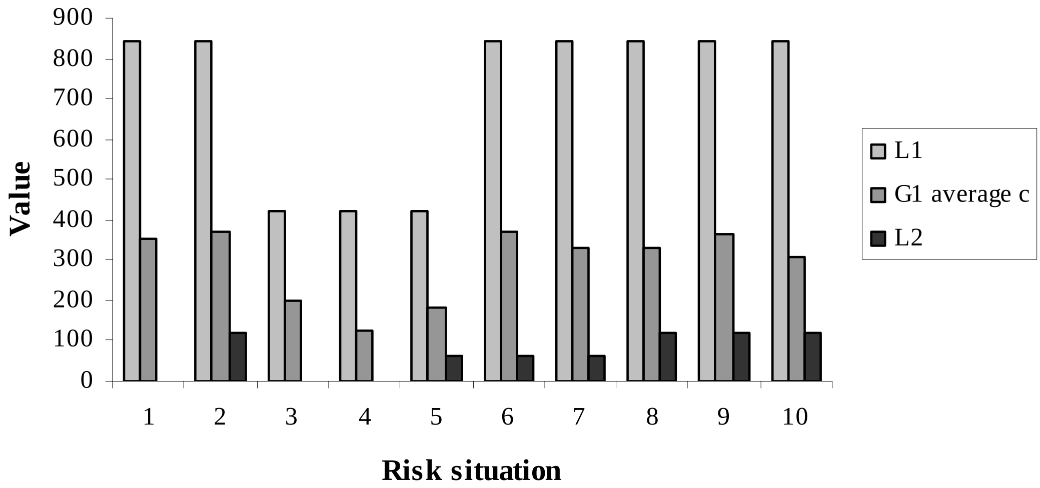

Figure 2: Group 2 Average Insurance Purchase, *c*-contracts

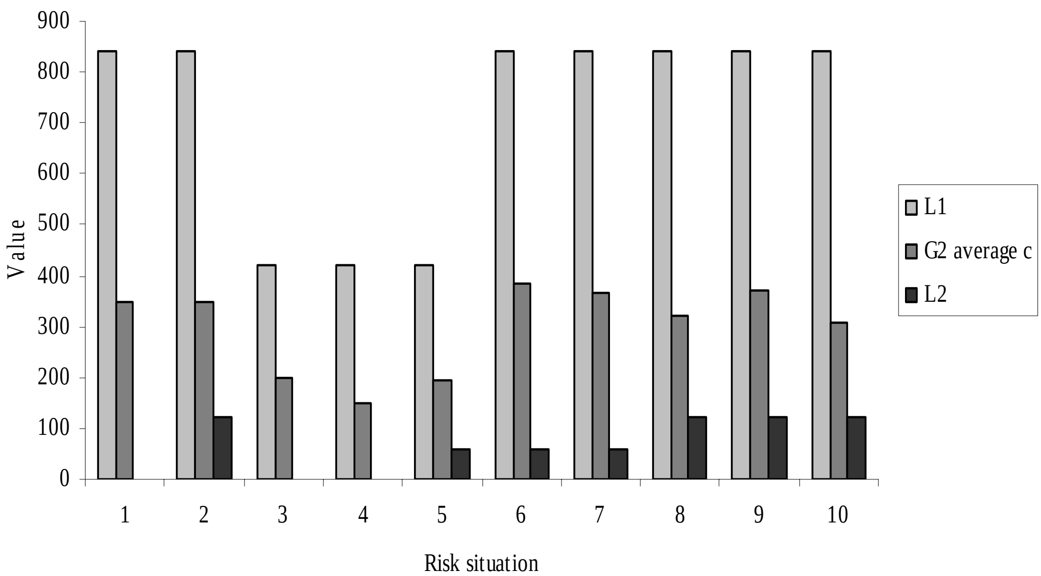

Figure 3: Group 1 Average Insurance Purchase, *d*-contracts

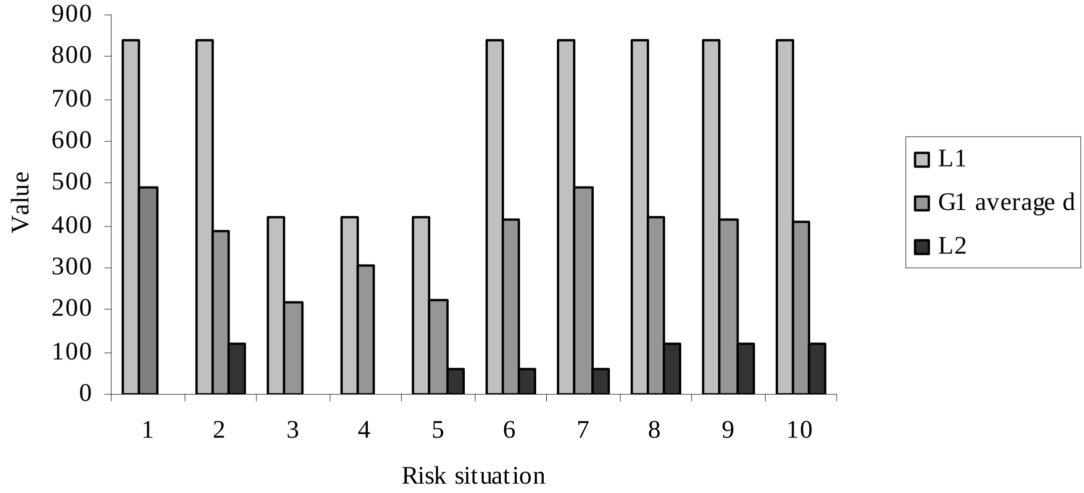

Figure 4: Group 2 Average Insurance Purchase, *d*-contracts

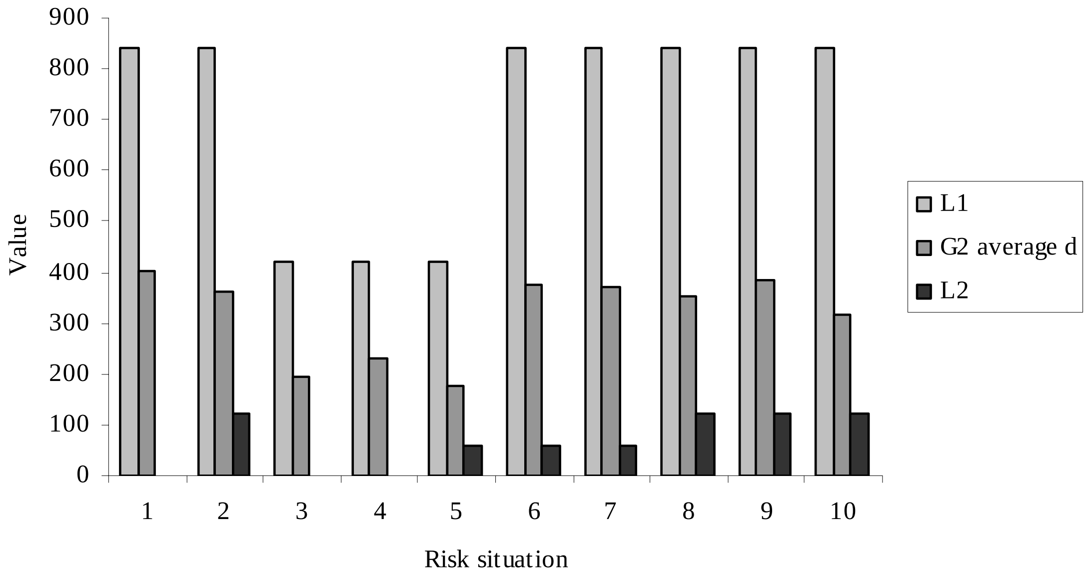

Figure 5: Group 1 Frequency of Risk Averse Responses

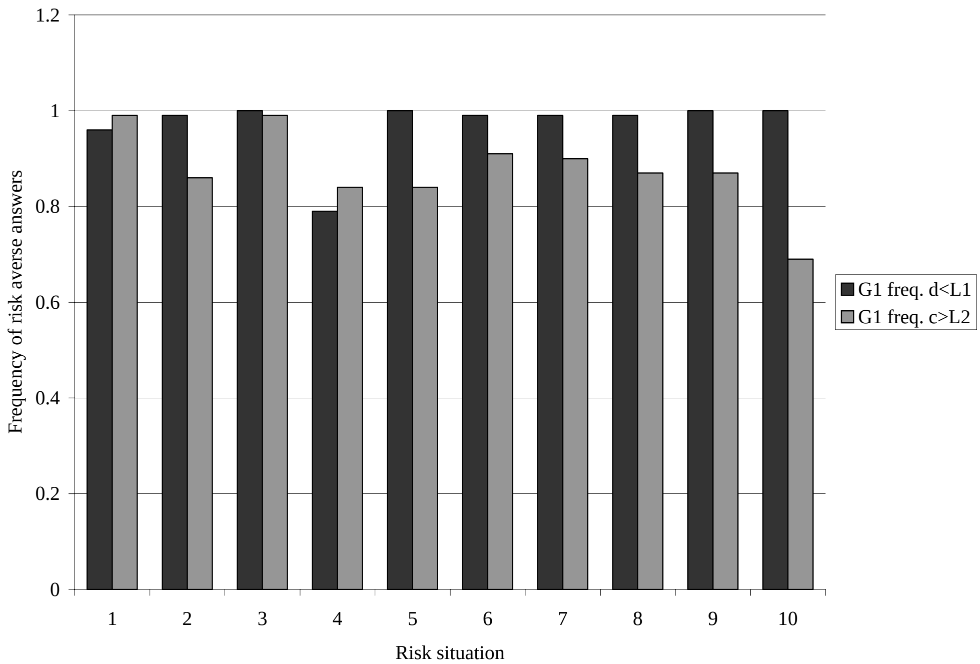

Figure 6: Group 2 Frequency of Risk Averse Responses

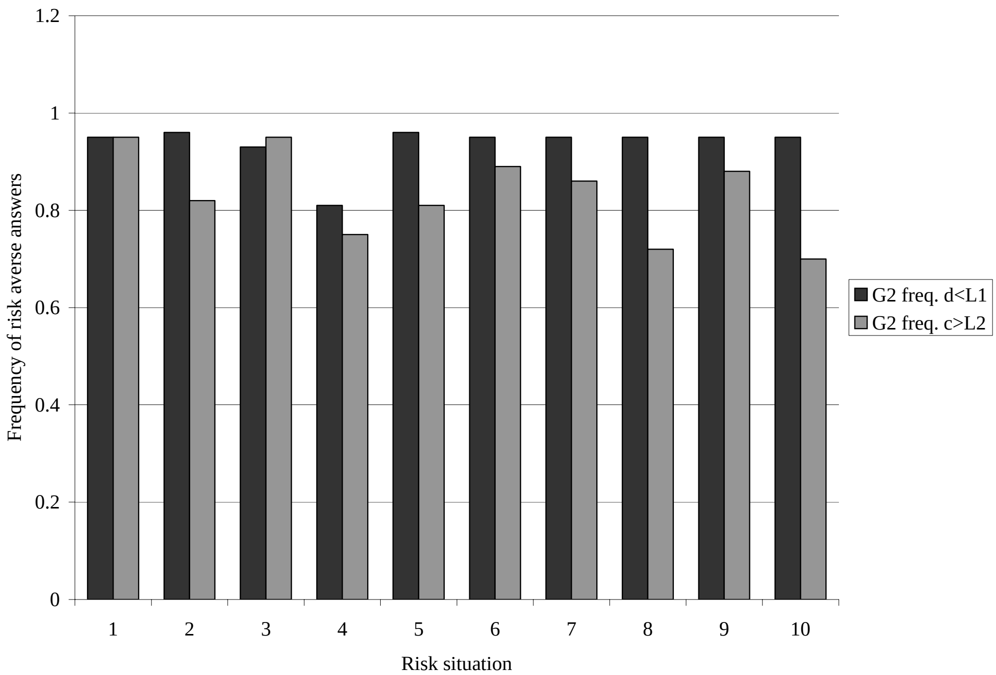

Table 3.1 Group 1 incidence of DARA and IARA

	d5,d6	c3,c5	c6,c9	c7,c8
1	D	I	D	D
2	D	I	NA	NA
3	----	D	----	D
4	D	D	D	----
5	----	I	I	I
6	D	D	D	----
7	D	----	I	D
8	D	I	D	I
9	I	I	D	----
10	D	I	D	NA
11	D	----	----	----
12	D	----	D	D
13	D	----	D	D
14	D	D	I	----
15	D	----	----	D
16	D	I	D	D
17	D	----	D	D
18	D	D	D	D
19	D	----	----	D
20	D	----	D	D
21	D	NA	I	D
22	D	D	----	I
23	D	I	D	NA
24	D	I	NA	NA
25	NA	D	I	----
26	D	I	D	----
27	D	----	----	D
28	I	I	I	D
29	D	----	D	D
30	D	I	D	D
31	NA	I	D	----
32	----	----	----	I
33	D	----	I	D
34	D	I	----	I
35	D	----	----	----
36	D	----	I	I
37	D	D	D	----
38	D	I	----	I
39	D	I	I	I
40	D	----	I	I
41	----	I	D	I
42	D	I	I	----
43	D	D	I	I
44	D	----	I	I
45	D	I	I	----
46	D	I	I	I
47	D	I	I	I
48	D	I	D	----
49	D	D	----	D
50	D	D	I	I
51	D	D	I	D
52	D	D	D	D
53	D	NA	NA	NA
54	D	D	D	D
55	D	NA	NA	NA
56	D	----	D	D
57	D	D	I	D
58	I	D	I	I
59	D	D	----	I
60	D	----	D	D
61	D	I	D	D
62	D	----	I	I
63	D	----	I	I
64	I	D	I	D
65	D	D	----	I
66	D	NA	NA	NA
67	D	D	----	----
68	D	----	D	D
69	D	----	I	D
70	D	I	I	----
71	I	----	----	I
72	D	I	NA	NA
73	D	----	----	----
74	D	----	----	D
75	I	NA	----	I
76	D	I	NA	NA
77	D	D	----	I
Nº D	65	21	27	31
Nº I	6	31	27	26

Table 3.2 Group 2 incidence of DARA and IARA

	d5,d6	c3,c5	c6,c9	c7,c8
1	NA	----	----	NA
3	D	D	----	D
4	----	----	----	----
5	D	NA	NA	NA
6	D	----	D	D
7	D	D	D	D
8	D	D	----	I
9	D	D	D	----
10	----	----	----	----
11	----	I	----	----
12	----	----	----	----
13	D	NA	NA	NA
14	NA	D	----	D
15	D	----	D	I
16	D	D	D	D
17	D	----	D	D
18	NA	D	NA	I
19	D	D	----	----
20	D	I	D	NA
21	D	I	D	D
22	----	----	I	----
23	D	D	----	----
24	D	I	----	D
25	----	----	I	D
26	D	NA	D	D
27	D	D	I	I
28	D	I	I	I
29	NA	D	I	D
30	D	----	----	D
31	D	I	D	----
32	D	I	D	D
33	I	D	I	I
34	----	----	I	I
35	D	D	D	I
36	D	I	D	D
37	D	I	I	I
38	D	I	I	I
39	D	I	I	I
40	D	I	----	D
41	D	D	D	----
42	D	D	I	D
43	D	----	I	I
44	D	----	----	----
45	D	I	----	----
46	NA	I	----	D
47	D	D	I	----
48	D	D	I	----
49	----	----	I	----
50	D	----	I	I
51	D	I	I	I
52	D	D	D	----
53	D	----	D	NA
54	D	I	D	D
55	----	D	I	I
56	----	D	D	I
57	D	I	I	I
Nº D	40	20	18	18
Nº I	1	17	19	17

Table 4 Aggregate analysis of result 8

situation	3	4	5	6	7	8	9	10
L_1+L_2	420.71	420.71	480.81	901.52	901.52	961.62	961.62	961.62
G1 av*c*+av*d*	418.34	427.03	402.76	786.78	818.00	748.53	780.54	714.97
G2 av*c*+av*d*	391.19	379.59	371.15	761.56	737.03	675.07	751.79	626.32

Table 5 Summary of the effects on optimal contracts of an increase in the probability of the small loss

risk situations	3 and 4		6 and 7		8 and 9		9 and 10		8 and 10	
group	1	2	1	2	1	2	1	2	1	2
d-contracts										
Average change	83.03	36.90	73.54	16.50	-16.31	24.53	10.93	-26.13	3.64	-8.39
Standard deviat.	113.17	115.13	180.33	332.26	153.80	113.05	199.45	177.68	223.11	153.27
c-contracts										
Average change	-74.34	-48.50	-44.86	-15.88	31.36	42.07	-49.34	-47.31	-21.85	-15.68
Standard deviat.	105.19	114.96	146.06	117.37	122.22	80.77	206.06	135.52	184.61	96.02

Table 6.1 Group 1, sign of product of coverage changes

	3,4	6,7	8,9	9,10	8,10
1	-	0	-	-	0
2	-	NA	NA	0	NA
3	-	-	NA	NA	-
4	-	-	0	NA	NA
5	0	0	0	0	0
6	-	-	0	0	0
7	-	-	0	-	-
8	-	+	0	NA	NA
9	-	-	NA	0	NA
10	-	-	NA	NA	NA
11	0	0	0	0	0
12	-	-	-	-	-
13	-	+	NA	NA	NA
14	-	-	-	0	-
15	-	-	0	-	-
16	-	0	0	-	-
17	0	-	-	0	+
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	0
21	-	-	-	0	-
22	0	-	-	-	+
23	-	NA	+	-	0
24	-	NA	NA	NA	NA
25	-	-	-	NA	NA
26	-	0	-	-	+
27	-	-	-	+	+
28	-	-	0	-	-
29	-	-	-	-	0
30	-	0	+	+	+
31	-	NA	NA	NA	NA
32	-	0	0	-	+
33	-	-	-	-	+
34	+	0	0	-	-
35	-	0	+	-	-
36	-	0	-	-	-
37	-	0	-	-	-
38	+	+	NA	0	NA
39	0	-	0	NA	NA
40	-	0	0	NA	NA
41	-	-	-	-	-
42	0	-	0	+	+
43	0	-	+	0	+
44	0	-	0	-	+
45	-	-	-	0	+
46	-	-	0	-	-
47	0	+	-	NA	NA
48	+	+	-	NA	NA
49	0	0	0	+	+
50	-	-	NA	NA	+
51	+	+	-	-	+
52	-	0	-	+	0
53	-	NA	NA	NA	NA
54	-	-	-	+	0
55	-	NA	NA	NA	NA
56	-	-	0	-	-
57	NA	-	0	-	0
58	+	+	+	+	+
59	0	+	-	-	0
60	-	-	-	-	-
61	-	-	-	NA	NA
62	-	-	-	-	-
63	-	0	0	-	-
64	-	-	-	NA	NA
65	-	0	0	0	0
66	-	NA	NA	NA	NA
67	0	0	-	-	-
68	-	0	+	-	-
69	-	0	+	+	0
70	-	+	0	+	-
71	-	0	NA	NA	NA
72	-	+	NA	NA	NA
73	-	0	0	-	0
74	-	0	-	-	-
75	-	0	0	0	0
76	-	+	NA	NA	NA
77	-	-	0	-	-
nº. +	5	11	7	9	15
nº. -	59	36	30	34	25
nº. 0	12	23	25	13	15

Table 6.2 Group 2, sign of product of coverage changes

	3,4	6,7	8,9	9,10	8,10
1	0	NA	NA	NA	NA
3	-	NA	-	-	-
4	0	-	0	0	0
5	-	0	NA	NA	NA
6	-	NA	-	-	-
7	0	-	0	-	-
8	-	0	0	-	-
9	-	-	-	-	0
10	0	0	0	0	0
11	-	0	0	NA	NA
12	0	0	0	0	0
13	0	0	NA	NA	NA
14	0	NA	NA	0	NA
15	-	NA	-	-	0
16	0	+	0	0	0
17	+	0	+	+	+
18	0	+	NA	NA	+
19	0	NA	0	+	+
20	-	+	0	+	+
21	-	NA	0	0	0
22	0	0	NA	NA	NA
23	+	0	0	+	+
24	0	+	0	0	0
25	0	0	0	+	-
26	0	0	0	0	0
27	-	0	0	0	-
28	-	+	+	-	0
29	-	0	0	-	-
30	-	-	0	0	0
31	0	-	-	-	0
32	-	0	0	-	-
33	-	0	+	+	0
34	-	+	NA	NA	NA
35	-	0	+	+	+
36	0	+	-	-	-
37	-	-	+	NA	NA
38	-	-	+	NA	NA
39	-	-	+	NA	NA
40	+	-	0	-	-
41	-	-	+	-	-
42	-	-	+	0	-
43	-	0	+	NA	NA
44	+	-	+	+	+
45	-	+	0	NA	NA
46	0	0	NA	NA	NA
47	0	NA	NA	NA	NA
48	0	NA	NA	NA	NA
49	0	NA	0	0	0
50	-	-	0	-	-
51	0	0	0	-	-
52	0	-	+	NA	NA
53	-	+	NA	NA	NA
54	0	-	+	-	-
55	0	-	NA	-	NA
56	+	0	NA	NA	NA
57	-	+	-	-	0
nº. +	5	11	13	8	7
nº. -	27	16	7	18	15
nº. 0	25	20	23	12	15

Table 7. Comparison of average contracted premiums under each contract format

Situation	3		4		5		6		7		8		9		10	
contract	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*	*d*	*c*
group 1																
average premium	66.29	65.50	12.96	13.65	66.89	103.03	141.75	167.00	77.27	120.89	97.19	168.11	144.50	207.35	55.21	141.75
standard dev.	24.79	22.44	12.71	12.56	33.71	40.23	64.16	70.31	42.47	50.65	54.13	64.70	73.74	78.49	44.24	49.27
group 2																
average premium	75.16	65.41	20.99	16.47	81.65	107.52	155.84	170.84	116.22	129.44	114.04	168.11	152.41	204.95	71.21	140.46
standard dev.	40.32	37.10	17.68	16.49	38.60	41.90	81.39	82.58	65.43	61.80	62.61	67.93	77.54	86.94	50.49	51.58

<u>Appendix 1 - Instructions for Participants</u>

You have been selected to participate in an experiment related to the design of insurance contracts. We thank you very much for your collaboration, and we hope that you think seriously about each of the situations that the experiment contains. To that end, a **PRIZE of 200,000 pesetas** will be awarded to the participant whose answers contain the least number of logical inconsistencies. Hence, your best strategy is to answer each situation according to your true preferences. **Please read these instructions carefully before proceeding.**

The experiment contains 10 risk situations that you must think about, and for which you are offered insurance. In each risk situation, you can suffer one of two possible losses, a small loss (which is sometimes equal to 0), and a large loss. The respective probabilities of each of the two losses are indicated in percentage terms, that is, if a given loss happens with probability 0.7, then this is indicated by the statement that the loss occurs with a probability of 70%. Of course, you should never think that it is ever possible to suffer, simultaneously, both losses, i.e., only one of the two losses will occur, either the small one or the large one.

For each situation, you are offered two insurance tables, with different contract formats, that enable you to reduce the risk of the situation. The table on the left hand side of the page represents insurance contracts with a deductible, that is, you limit your maximum loss amount to the deductible chosen, plus the corresponding premium. For example, consider situation 5. If you choose (from the left hand table), a deductible of 20,000 pesetas, and the loss turns out to be 70,000 pesetas (this occurs with a probability of 30%), then you will loose only 20,000 pesetas, while the (hypothetical) insurance company will be responsible for the other 50,000 pesetas. On the other hand, if the loss turns out to be 10,000 pesetas (this occurs with a probability of 70%), then you alone will loose 10,000 pesetas. In either case (that is, independently of the final value of the loss), bear in mind that you will also be charged the corresponding premium, which in the case of a 20,000 peseta deductible is 16,500 pesetas.

The table on the right represents the case of insurance contracts with an upper limit on coverage (that is, you get a minimum limit to your own loss). For example, consider once again situation 5. If you choose (in the right hand table) a coverage of 20,000 pesetas, and the loss turns out to be 70,000 pesetas, then you will be responsible for 50,000 pesetas and the other 20,000 pesetas (your coverage) will be paid by the insurer. On the other hand, if the loss turns out to be 10,000 pesetas, since this is below your coverage limit, you will suffer no loss at all, and the insurer will be responsible for the 10,000 peseta loss. Once again, bear in mind that in either case, you must pay the corresponding premium, which is 14,300 pesetas for a coverage of 20,000 pesetas.

For each situation, you must choose the insurance option that you most prefer **from both tables** (choose the best one from the left hand table, and the best one from the right hand table). Please indicate you choices by enclosing the preferred option in a circle. Once you have chosen the best option from each table, please then indicate **which of these two preferred options is the overall preferred choice** by placing an asterisk beside the overall preferred option. If you happen to be indifferent between the most preferred option in each table, please indicate this by placing an asterisk beside both of the circled options.

As an example, assume that in situation 3 you prefer a deductible of 30,000 pesetas in the left hand table and a coverage of 20,000 pesetas in the right hand table, and then between these two options, your overall preferred choice is the coverage contract, then your questionnaire should appear marked as follows:

Table 3.1

Deductible	Premium
0	23,100
10,000	19,800
20,000	16,500
30,000	13,200
40,000	9,900
50,000	6,600
60,000	3,300
70,000	0

Table 3.2

Coverage	Premium
0	0
10,000	3,300
20,000	6,600 *
30,000	9,900
40,000	13,200
50,000	16,500
60,000	19,800
70,000	23,100

SITUATION 1

In this situation, there is an 80% probability of suffering a loss of 0 pesetas, and a 20% probability of suffering a loss of 140,000 pesetas.

Table 1.1

Deductible	Premium
0	28,000
10,000	26,000
20,000	24,000
30,000	22,000
40,000	20,000
50,000	18,000
60,000	16,000
70,000	14,000
80,000	12,000
90,000	10,000
100,000	8,000
110,000	6,000
120,000	4,000
130,000	2,000
140,000	0

Table 1.2

Coverage	Premium
0	0
10,000	2,000
20,000	4,000
30,000	6,000
40,000	8,000
50,000	10,000
60,000	12,000
70,000	14,000
80,000	16,000
90,000	18,000
100,000	20,000
110,000	22,000
120,000	24,000
130,000	26,000
140,000	28,000

SITUATION 2

In this situation, there is a probability of 80% of suffering a loss of 20,000 pesetas, and a probability of 20% of suffering a loss of 140,000 pesetas.

Table 2.1

Deductible	Premium
0	44,000
10,000	34,000
20,000	24,000
30,000	22,000
40,000	20,000
50,000	18,000
60,000	16,000
70,000	14,000
80,000	12,000
90,000	10,000
100,000	8,000
110,000	6,000
120,000	4,000
130,000	2,000
140,000	0

Table 2.2

Coverage	Premium
0	0
10,000	10,000
20,000	20,000
30,000	22,000
40,000	24,000
50,000	26,000
60,000	28,000
70,000	30,000
80,000	32,000
90,000	34,000
100,000	36,000
110,000	38,000
120,000	40,000
130,000	42,000
140,000	44,000

SITUATION 3

In this situation, there is a probability of 70% of suffering a loss of 0 pesetas, and a probability of 30% of suffering a loss of 70,000 pesetas.

Table 3.1

Deductible	Premium
0	23,100
10,000	19,800
20,000	16,500
30,000	13,200
40,000	9,900
50,000	6,600
60,000	3,300
70,000	0

Table 3.2

Coverage	Premium
0	0
10,000	3,300
20,000	6,600
30,000	9,900
40,000	13,200
50,000	16,500
60,000	19,800
70,000	23,100

SITUATION 4

In this situation, there is a probability of 90% of suffering a loss of 0 pesetas, and a probability of 10% of suffering a loss of 70,000 pesetas.

Table 4.1

Deductible	Premium
0	7,700
10,000	6,600
20,000	5,500
30,000	4,400
40,000	3,300
50,000	2,200
60,000	1,100
70,000	0

Table 4.2

Coverage	Premium
0	0
10,000	1,100
20,000	2,200
30,000	3,300
40,000	4,400
50,000	5,500
60,000	6,600
70,000	7,700

SITUATION 5

In this situation, there is a probability of 70% of suffering a loss of 10,000 pesetas, and a probability of 30% of suffering a loss of 70,000 pesetas.

Table 5.1

Deductible	Premium
0	30,800
10,000	19,800
20,000	16,500
30,000	13,200
40,000	9,900
50,000	6,600
60,000	3,300
70,000	0

Table 5.2

Coverage	Premium
0	0
10,000	11,000
20,000	14,300
30,000	17,600
40,000	20,900
50,000	24,200
60,000	27,500
70,000	30,800

SITUATION 6

In this situation, there is a probability of 70% of suffering a loss of 10,000 pesetas, and a probability of 30% of suffering a loss of 140,000 pesetas.

Table 6.1

Deductible	Premium
0	53,900
10,000	42,900
20,000	39,600
30,000	36,300
40,000	33,000
50,000	29,700
60,000	26,400
70,000	23,100
80,000	19,800
90,000	16,500
100,000	13,200
110,000	9,900
120,000	6,600
130,000	3,300
140,000	0

Table 6.2

Coverage	Premium
0	0
10,000	11,000
20,000	14,300
30,000	17,600
40,000	20,900
50,000	24,200
60,000	27,500
70,000	30,800
80,000	34,100
90,000	37,400
100,000	40,700
110,000	44,000
120,000	47,300
130,000	50,600
140,000	53,900

SITUATION 7

In this situation, there exists a probability of 80% of suffering a loss of 10,000 pesetas, and a probability of 20% of suffering a loss of 140,000 pesetas.

Table 7.1

Deductible	Premium
0	39,600
10,000	28,600
20,000	26,400
30,000	24,200
40,000	22,000
50,000	19,800
60,000	17,600
70,000	15,400
80,000	13,200
90,000	11,000
100,000	8,800
110,000	6,600
120,000	4,400
130,000	2,200
140,000	0

Table 7.2

Coverage	Premium
0	0
10,000	11,000
20,000	13,200
30,000	15,400
40,000	17,600
50,000	19,800
60,000	22,000
70,000	24,200
80,000	26,400
90,000	28,600
100,000	30,800
110,000	33,000
120,000	35,200
130,000	37,400
140,000	39,600

SITUATION 8

In this situation, there is a probability of 80% of suffering a loss of 20,000 pesetas, and a probability of 20% of suffering a loss of 140,000 pesetas.

Table 8.1

Deductible	Premium
0	48,400
10,000	37,400
20,000	26,400
30,000	24,200
40,000	22,000
50,000	19,800
60,000	17,600
70,000	15,400
80,000	13,200
90,000	11,000
100,000	8,800
110,000	6,600
120,000	4,400
130,000	2,200
140,000	0

Table 8.2

Coverage	Premium
0	0
10,000	11,000
20,000	22,000
30,000	24,200
40,000	26,400
50,000	28,600
60,000	30,800
70,000	33,000
80,000	35,200
90,000	37,400
100,000	39,600
110,000	41,800
120,000	44,000
130,000	46,200
140,000	48,400

SITUATION 9

In this situation, there is a probability of 70% of suffering a loss of 20,000 pesetas, and a probability of 30% of suffering a loss of 140,000 pesetas.

Table 9.1

Deductible	Premium
0	61,600
10,000	50,600
20,000	39,600
30,000	36,300
40,000	33,000
50,000	29,700
60,000	26,400
70,000	23,100
80,000	19,800
90,000	16,500
100,000	13,200
110,000	9,900
120,000	6,600
130,000	3,300
140,000	0

Table 9.2

Coverage	Premium
0	0
10,000	11,000
20,000	22,000
30,000	25,300
40,000	28,600
50,000	31,900
60,000	35,200
70,000	38,500
80,000	41,800
90,000	45,100
100,000	48,400
110,000	51,700
120,000	55,000
130,000	58,300
140,000	61,600

SITUATION 10

In this situation, there is a probability of 90% of suffering a loss of 20,000 pesetas, and a probability of 10% of suffering a loss of 140,000 pesetas.

Table 10.1

Deductible	Premium
0	35,200
10,000	24,200
20,000	13,200
30,000	12,100
40,000	11,000
50,000	9,900
60,000	8,800
70,000	7,700
80,000	6,600
90,000	5,500
100,000	4,400
110,000	3,300
120,000	2,200
130,000	1,100
140,000	0

Table 10.2

Coverage	Premium
0	0
10,000	11,000
20,000	22,000
30,000	23,100
40,000	24,200
50,000	25,300
60,000	26,400
70,000	27,500
80,000	28,600
90,000	29,700
100,000	30,800
110,000	31,900
120,000	33,000
130,000	34,100
140,000	35,200