Insurance, risk aversion, and loss manipulation: An experiment

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Abstract

We challenge the view that consumers and insurers in insurance markets have a common interest to minimize the value of potential losses. We do this in two ways. First we derive the theoretical result that when consumers are risk-averse, an insurer's profits increase with potential loss size. This prediction is subsequently tested in an experimental market insurance game. Our findings show that insurer-subjects do indeed set high losses to induce consumer-subjects to buy insurance and to exploit their risk-aversion. In case of competing insurer-subjects the loss size is reduced but not eliminated. The policy implication is that one should not grant insurance companies buyer-power on grounds that they are an effective countervailing power to offset provider market power.

JEL classification: C92, D81, G22, I11, L13
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1 Introduction

> "140 euro is a ridiculous amount to pay for repairing a cracked windshield. I had the shield repaired for 35 euro by an unofficial car mechanic. It really bothers me that car mechanics can charge these amounts to insurance companies. In the end, the car driver has to pay through his insurance premium so the insurers do not seem to care at all."
>
> From the forum of Autoweek.nl [translated from Dutch]

Whereas the impact of market power is generally considered to have a detrimental effect on consumer welfare, the literature seems to take a somewhat more favorable stance to market power by insurers. The argument is that the interests of consumers and insurers are aligned because they both benefit from lower prices charged by service suppliers. For this reason, insurers may act as an effective countervailing power to offset provider market power. As McKnight *et al.* (2011) put it in their recent empirical study on the prices paid for health care by insurers and the uninsured: "Market power for insurers can offset provider market power. (p.10)" and "Insurers are likely better buyers of services than other expert buyers, like concierges or securities brokers, because they face strong incentives to minimize costs. (p.22)"

A critical implicit assumption in this line of reasoning is that the market under consideration actually is an insurance market: the insurance covers a given risk which is relatively large in the sense that, would it materialize, it would have a significant impact on the wealth of the uninsured consumer. A neglected issue so far is what happens if the market power enables the insurer to turn non-insurance markets into insurance markets, by increasing the risk to which the uninsured are exposed. This risk manipulation could take the form of either increasing the loss probability or by increasing the potential loss. Indeed, insurers may not have incentives to use their countervailing power to bring down the cost structure of the service supplier. The reason is that every cost reduction also reduces the risk to which the uninsured are exposed, which directly threatens the existence of the market for insurance. In the extreme case where the insurer would successfully eliminate the probability that a loss would occur or manages to reduce the potential loss size to zero, he would be out of business.[1]

This paper addresses the question how important the latter consideration is for the insurer's strategy. If it significantly affect insurer's behavior wide-ranging policy implications would arise: it implies that the insurers' countervailing power may not only be a blunt tool in forcing service suppliers to curb costs, but that it may even be detrimental to consumer welfare. This may happen in cases where their market power enables insurers to protect or create insurance markets, for example by blocking the introduction of cost-saving technologies, blocking the entry of cheaper suppliers or by stimulating service suppliers to bundle different services into a more expensive product. Systems of preferred suppliers can be an effective means to achieve these objectives. Oftentimes, insurance policies only cover a loss when their customer visits one of their selected service suppliers for repair or treatment. Insurance companies typically claim that they only select certified suppliers that satisfy the highest quality standards. [2] However, this higher quality mostly comes along with a higher price.

[1] This distinguishes insurance markets from other product markets with vertical relations between upstream and downstream suppliers. In those markets, the upstream producer almost never sells directly to final customers. In insurance markets, the insurer covers the cost in case the insured customer has to buy the product, but the customer also has the option to go uninsured and to buy directly from the supplier paying the expenses herself. The uninsured option is a direct threat to the insurer's business.

[2] To give an example, the website of Interpolis, a leading Dutch insurance company, states the following [translated from Dutch]: "As of September 22, 2010 Interpolis works for repairing window damage only with recovery companies that are affiliated with the FOCWA or BOVAG. These organizations set strict demands on quality, warranty and service. They monitor connected recovery companies there regularly. Interpolis wishes for its customers the highest standard of service and has therefore opted for this change in the policy conditions." https://www.interpolis.nl/over-interpolis/media/nieuwsberichten/2010/Paginas/erkende-bedrijven-herstellen-ruitschade-interpolisklanten.aspx

Our contribution in this paper is twofold. We first show that theoretically, insurers have an incentive inflate the loss when consumers are risk averse. We then take this prediction to the lab to examine if in practice, insurer-subject seize the opportunity to increase the potential loss size to maximize their profits. To this end, subjects are grouped in markets of six participants, one of them receiving the role of insurer, the other five acting as consumers. In each period, the consumers each receive an endowment of €20 but they may lose part or all of this endowment with a given probability. The insurer decides on the amount at risk (the potential loss size) and sets a premium. Consumers subsequently make the binary decision to either taking insurance by paying the premium to the insurer or to go uninsured. In the final step, nature decides whether the consumers experiences a loss in that period. We also have treatments with seven participants whereby two subjects have the role of insurer and the remaining five subjects can choose between these insurers when buying insurance, if at all.

The role of moral hazard in creating excess demand and thereby high social costs has received a lot of attention in the literature on insurance markets. We ignore these issues in the current paper and throughout assume that all agents have perfect information.Instead, we investigate what incentives insurers have to engage in loss prevention in contexts where these activities potentially have a negative impact on the demand for insurance. In doing this, we focus on the insurers incentives to influence the size of the potential loss. Most related to our paper is the theoretical contribution by Schlesinger and Venezian (1986, SV hereafter) who also examine the insurer's (expected) profit-maximizing strategy in markets where he can engage in loss prevention. Schlesinger and Venezian (1986) focus on the situation where the insurer has the ability to alter the loss probability rather than on the size of the potential loss. They compare the probability p^* that maximizes the insurer's profits with an initial loss probability p_0; if $p^* > p_0$, the insurer would like to increase the probability of a loss, and if $p^* < p_0$, the insurer would like to decrease the probability of a loss. To our surprise, in their analysis, they simply assume that $p^* < p_0$, arguing that (p. 232): *"Although the insurer may wish to increase the probability of a loss - perhaps by lobbying Congress to block some proposed safety legislation -, such action is likely to meet with resistance from the individual (...) as well as from insurance regulators. On the other hand, efforts of the insurer to reduce the probability of a loss are likely to be lauded as an example of the insurer's concern for the welfare of his clients"*. Based on this partial analysis, Schlesinger and Venezian (1986) reach the conclusion (quoted from the abstract of their paper) that: "We (...) demonstrate that a consumer may be better off when the insurance market is monopolistic rather than competitive."

Our main experimental findings are the following. First of all, the actual behavior of consumer-subjects is in line with theory in that a higher loss size would allow an insurer to earn more profits. Second, in case of monopoly insurers, the insurer-subjects are quite well able to determine the profit-maximizing combination of loss size and premium. In particular, the loss size set by the insurer is close to €20 with a premium of about €14, given the loss probability of 60%. Third, competition between insurers reduces the loss size, but not as much as theory would predict. In case the market is not an insurance market, the loss size uninsured consumers face hovers around €8. Remarkably, in non-insurance markets consumers end up paying a slightly higher premium than in insurance markets. Still, competition on non-insurance markets erodes all insurer profits while competing insurers do manage to realize high earnings in insurance markets.

The paper proceeds as follows. Section 2 presents a theoretical framework. This naturally leads us to the formulation of the research hypotheses that will guide our experimental analysis. Section 3 discusses the experimental design. Section 4 gives a summary of the different sessions conducted. Section 5 presents the experimental results and analyzes them in light of the formulated research hypotheses. Section 6 concludes.

2 Theory and research hypotheses

Suppose that demand for insurance is given by $D(R(L))$, with $R(L)$ the premium to be paid which is a function of the potential loss L. Then the expected profits $\pi(L)$ of an insurer charging a premium $R(L)$, equal

$$E[\pi(L)] = D(R(L))\left[R(L) - E(L)\right]. \tag{1}$$

Consider the case where risk-averse consumers (that is, consumers whose utility function $U(\cdot)$ is strictly concave: $U' > 0$ and $U'' < 0$) with an initial wealth endowment W face a potential loss L that will occur with a given probability p. This case is depicted in Figure 1. The expected utility when uninsured is

$$pU(W - L) + (1 - p)U(W).$$

The premium $R(L)$ that makes the consumer indifferent between buying insurance against the risk, and receiving the certainty equivalent $CE(L) \equiv W - R(L)$, and staying uninsured, is the solution to the equation

$$U(W - R(L)) = pU(W(L) - L) + (1 - p)U(W).$$

From Figure 1, the following proposition immediately follows.

Proposition 1 *When consumers are risk-averse, the expected profits of an insurer charging a premium $R(L) = W - CE(L)$ are positive.*[3]

[3] We assume that everyone indifferent between buying insurance or not decides to buy insurance.

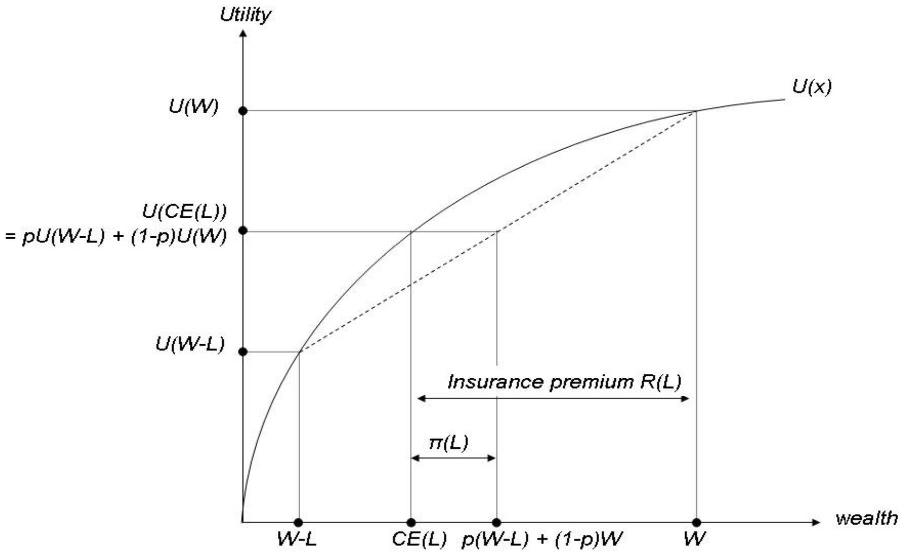

Figure 1: Risk aversion and insurance premium.

Proof: The expected profits on each insurance policy sold equal

$$\begin{aligned} E[\pi(L)] &= R(L) - pL = (W - CE(L)) - pL = W - U^{-1}[U(CE(L))] - pL \\ &= W - U^{-1}[pU(W-L) + (1-p)U(W)] - pL \\ &> W - U^{-1}[U(p(W-L) + (1-p)W)] - pL \\ &= W - p(W-L) - (1-p)W - pL = 0. \end{aligned}$$

It is also easy to show that an insurer's profits increase with the size of the loss L.

Proposition 2 *When consumers are risk-averse, the expected profits of an insurer charging a premium $R(L) = W - CE(L)$ are increasing in L.*

Proof:

$$\begin{aligned}
\frac{dE[\pi(L)]}{dL} &= d\left\{W - U^{-1}[pU(W-L) + (1-p)U(Y)] - pL\right\}/dL \\
&= -d\left\{U^{-1}[pU(W-L) + (1-p)U(W)]\right\}/dL - p \\
&> -d\left\{U^{-1}[U(p(W-L) + (1-p)W)]\right\}/dL - p \\
&= -d\left\{pW - pL + (1-p)W\right\}/dL - p \\
&= 0.
\end{aligned}$$

Proposition 2 theoretically shows that a profit maximizing monopolistic insurer will increase the size of the potential loss to the maximal value. When consumers have identical levels of risk aversion, a higher loss size L increases the insurer's profits by widening the gap between the expected utility of being uninsured and its certainty equivalent (the amount of wealth left to the customer when she has paid the premium); when consumers have heterogeneous risk preferences, the higher loss size will increase the demand for the insurer's product for a given premium R. In previous research, it has been argued that in practice, insurers are not likely to increase a given initial loss size L_0 to create higher demand because it will be met by consumer resistance and/or regulation.[4] We wish to take this discussion one step back by asking the question: Absent these societal checks and balances, do insurers with market power inflate the loss size to increase profits? We address this question by creating experimental markets with subjects randomly assigned the role of insurer or consumer. To assess whether competition instead of regulation is able to reign in possible misbehavior by the insurer, we implement both monopoly and duopoly markets.

[4]Schlesinger and Venezian (1986, p. 232, fn. 9) note: "Alternatively, we could assume that any loss-reduction measures taken by the insured can be superseded by the actions of the insurer. More realistically, we would probably expect the individual to try to counteract attempts by the insurer to increase the probability of a loss. This might limit the insurer to considering only the possibility of lowering the loss probability."

2.1 Research hypotheses

Consumer-subjects in the experiment receive an initial endowment of $W = 20$. They face the risk to lose L of their endowment with probability $p = 0.6$ but can insure against this potential loss by buying coverage from the insurer-subject at premium R. In treatment #1, the potential loss size L is exogenously given and equals $4, 8, 12$ or 16 and the monopolistic insurer only sets the premium. In treatment #2, the monopolistic insurer sets both premium and loss size (both in the range $[0, W]$. For each consumer that takes insurance with him, he receives the premium R (the insurer cannot price discriminate between consumers). In case one of his customers experiences a loss, the insurer has to pay the cost equal to L_1. This value L_1 is to be interpreted as the price the insurer has agreed with the service supplier. Note that in the experiment, the insurer-subject is fully in charge and sets L_1. This is akin to a situation where the service has no bargaining power, for example because insurance company are vertically integrated or the upstream market of service suppliers is characterized by perfect competition. An important remaining question is which potential loss L uninsured consumers face. In the two duopoly treatments of the experiment, this potential loss for the uninsured is determined as

$$L = max(min\{L_1, L_2\}, L_0), \tag{2}$$

with L_0 the initial loss size and L_i the loss size set by insurer i; for the monopoly treatment, we use the same formula with L_2 simply set to 0. We implement two choices of L_0: $L_0 = 0$ and $L_0 = 20$. Below we discuss for both choices the equilibrium properties of monopoly and duopoly markets under the assumptions that consumers are risk-averse and insurers are risk-neutral

$L_0 = 0$ The $L_0 = 0$ market is not an insurance market because without insurers, consumers would face a loss of $L = L_0 = 0$ and the presence of insurers thus can only increase the potential loss of the uninsured (see equation (2)). The risk-neutral monopolistic insurer has an incentive to set L_1, and thereby L, higher than zero because otherwise there will be no market for his product. We will call this consideration the "demand effect". Proposition 2 predicts that a he will set L_1 to the maximal value of 20. With risk-averse consumers, the profit-maximizing premium will be $R_1 > pL = 0.6 \times 20 = 12$, with the exact value depending on the degree of risk aversion.

For the duopoly market, the equilibrium prediction is slightly less clear-cut but we will show that the unique equilibrium is the one where the insurers set $R_1 = R_2 = L_1 = L_2 = 0$. That is, the introduction of competition in the insurance market sparks a race-to-the-bottom in premiums and loss sizes. In effect, because uninsured consumers face a potential loss of $L = 0$, the insurance market will altogether disappear. To reach this conclusion, first note that none of the insurers can make a positive expected profit. Consumers who buy insurance will always buy from the insurer who charges the lowest premium (for both insurers offer protection against the same potential loss L), without loss of generality assume that $R_1 \leq R_2$. Then the profits of insurer 2 are 0. The expected profits of insurer 1 are positive if and only if he sets L_1 such that $R_1 > 0.6L_1$. But this cannot be an equilibrium because insurer 2 can increase his profits by undercutting the premium of insurer 1. Therefore, in any equilibrium, it has to hold that $R_i = p \times L_i$. We are left to show that in equilibrium, $L_i = 0$. Our proof is by contradiction. Suppose an equilibrium in which $L_1 > 0$ and $R_1 = p \times L_1$. In this case, insurer 2 could attain a positive expected profit by setting $L_2 = L_1 - \epsilon$ (with ϵ an arbitrary small number) and charging a premium $R_2 = p(L_1 - \epsilon) + \delta = R_1 - p\epsilon + \delta$ with $\delta < p\epsilon$ and small enough for the consumers to prefer taking insurance to staying uncovered. But then $L_1 > 0$ and $R_1 = p \times L_1$ cannot be an equilibrium.

$L_0 = 20$ The $L_0 = 20$ market is an insurance market. In this situation, uninsured consumers always face a potential loss equal to $L = L_0 = 20$, independent of the presence of insurers and their choices of L_i (again see equation (2)). Consumers can therefore only benefit from the presence of one or more insurance companies, because these can offer them protection against a large potential loss by paying a certain premium. On the other hand, the monopolistic insurer does not have to worry that lowering L_1 will reduce the demand for his product; there is not demand effect. For this reason, and because L_1 is the price the insurer has to pay to the service supplier in case one of his customers experiences a loss, he has an incentive to set L_1 as low as possible, that is: equal to 0. As in the $L_0 = 0$ case, the profit-maximizing premium will be $R_1 > pL = 0.6 \times 20 = 12$, with the exact value again depending on the degree of risk aversion. The analysis for the duopoly market is similar to the $L_0 = 0$ case: the unique equilibrium is when $R_1 = R_2 = L_1 = L_2 = 0$.

Table 1: Research hypotheses on the expected loss sizes L and premium R set by the insurer (risk-averse consumers, loss probability $p = 0.6$).

	Monopoly		Duopoly	
initial loss size	L	R	L	R
$L_0 = 0$	20	>12	0	0
$L_0 = 20$	0	>12	0	0

The theoretical predictions regarding the choices made by the insurer-subjects in the experiment are summarized in Table 1. These theoretical predictions are the research hypotheses of our experimental investigation. The table shows that insurers who can manipulate the loss size are able to create an insurance market when they have market power but that this does not happen when there is sufficient competition among insurers. Given sufficient competition, there is thus no need for regulation or for individual consumers to monitor the insurer's actions.

3 Experimental design

Our experiment consists of two stages. In the second stage, groups of six subjects each are formed with one group member assigned the role of insurer, the other five act as consumers. For 30 periods, the insurer chooses the premium R for which consumers in her group can insurance themselves gainst the event of a loss. Consumers subsequently choose whether or not to buy insurance.

We implement a total of four treatments, two Monopoly treatments and two Duopoly treatments. All treatments consist of two stages. The first stage is designed to elicit the individual level of risk-aversion of subjects. Subjects play this stage in isolation and this stage is the same for all treatments. In the second stage subjects play a market insurance in groups of 6 (monopoly-treatment) or 7 (duopoly-treatment) subjects. The difference between the two monopoly treatments is that in treatment # 1 the subject with the role of insurer can only decide on the premium R with the size of the potential loss L given, whereas in treatment #2, the monopolistic insurer faces the somewhat more difficult decision problem of having to decide on the combination of loss size L and premium R at the same time. In the second stage of the duopoly treatments, two randomly chosen subjects are assigned the role of insurer who can each individually choose L and R. The two duopoly treatments differ in the potential loss size faced by uninsured subjects. These differences are explained further below where we discuss the two stages in more detail.

3.1 Stage I: Risk elicitation

The first stage of the experiment measures the individual risk preferences of all participating subjects. Our procedure closely follows the one applied by Von Gaudecker, Van Soest and Wengström (2011) who also use multiple price lists with pie-charts as a graphical tool to help describing the probabilities of the outcomes. Harrison and Rutström (2008) review the different risk elicitation methods used in the laboratory including the multiple price list design. We refer the interested reader to their paper for details and the advantages and drawbacks of each method. We will only give a description of our design and indicate at which points we depart from the literature.

Each subject is presented with a screen containing a $6x2$ payoff matrix such as shown in Figure 2. In each row, subjects have to choose between option A or option B. This binary choice is between two lotteries but in our design, the lottery headed under 'Option B" is always degenerate: it gives an amount with 100% probability. This is a departure from most of the literature, including Von Gaudecker *et al.* (2011). We chose this setup because it makes the decision-making process for subjects very similar to the one they face in Stage II, where the choice is also between a non-degenerate lottery (not insure) and a certain amount (take insurance). The payoff matrices are designed such that a risk-neutral subject will always prefer option A in the first row and option B in the last row and will switch from A to B in some of the intermediate rows. The procedure does not impose monotonicity and in principle allows subjects to switch from A to B in a certain and to switch back to A in a later row. If subjects show consistent behavior, they are directed to a sub-screen with the same payoffs but a finer probability grid with steps of 5%.

Subjects face a total of 25 screens (50 including sub-screens) with each screen depicting a particular loss size-premium (L, R)-combinations with $L = 4, 8, 12, 16, 20$ and $R = 2, 4, \ldots 18$ and $R > L$. In total, subjects thus make 150 (300) decisions in Stage I.[5]

There is a rich literature on risk and risk perception that measures peoples' risk attitude in the experimental lab or in the field (e.g. Beetsma and Schotman, 2001). The common finding of these studies is that most people are risk-averse (i.e. they prefer a certain sum of money to an uncertain bet that gives them the same sum in expected value), and tend to overestimate the value of avoiding low-probability risks

[5]To compare, in the elicitation design of Von Gaudecker *et al.* (2011) subjects make 28 to 56 decisions including possible sub-screens.

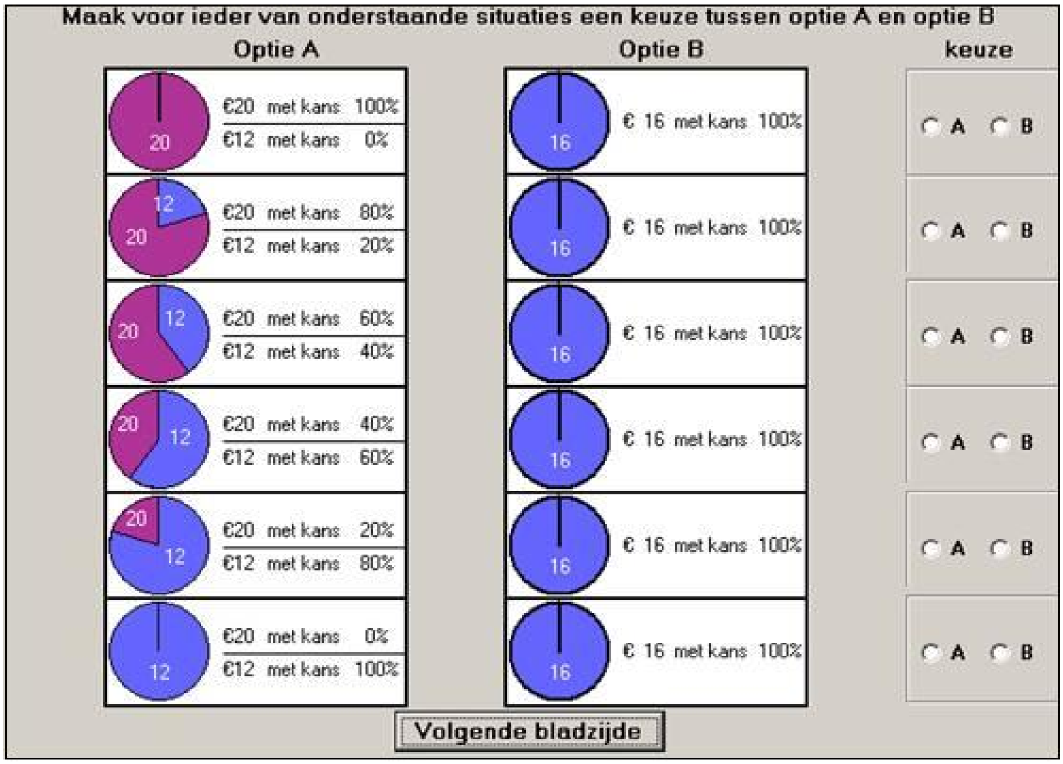

Figure 2: Example of a Stage I multiple price list decision screen.

(McClelland et al., 1993). Another experimental finding, and one that is particularly relevant for the current context, is that individuals tend to have a disproportionate preference for certainty (Andreoni and Sprenger, 2010; Abdellaoui et al., 2011). Von Gaudecker, van Soest and Wengström (2011) have shown that risk preferences differ across subjects and that it is better to estimate individual specific parameters.

All these studies however, have focused on estimating the (individual) degree of risk aversion by presenting subjects with different sets of bets provided by the researcher, just as we do in Stage I. We are not aware of studies that investigate the question, which set of bets a profit-maximizing supplier of bets will offer to buyers at what price, given that he knows the distribution of risk attitudes of the population of buyers. This is one of the elements we add in Stage II of the experiment.

3.2 Stage II: The market insurance game

The second part last for 30 periods. Subjects are randomly matched into groups of 6 or 7 subjects ("'markets"). In the monopoly (duopoly) treatment, in each group one (two) randomly chosen subject(s) are assigned the role of insurer; the remaining five subjects have the role of consumer.

Subjects with the role of consumer are given an initial endowment of $W = e20$. In each period, the insurer-subjects in the group have the task to set a premium R_i for an insurance that protects insured consumers against the event of a loss. In the monopoly treatment with exogenous loss size, the given loss size L is the same in periods 1 to 15 and periods 16-30 but changes in period 16. That this change will occur is common knowledge to all subjects. To control for order effects, the direction in which the potential loss changes is switched between sessions. In the endogenous loss size treatments 2-4, the insurers determine a loss size L_i. This loss size is to be interpreted as the agreed upon price they pay to a service supplier in case one of the insurees experiences a loss. Uninsured consumers face a potential loss of L, with L determined by equation (2). Losses L occur with a given probability $p = 0.60$. After having learnt the premium(s) and the potential loss L, consumers decide whether or not to insure themselves against the event of a loss. Figure 3 shows an example of a decision screen consumers face in Stage II: when uninsured, consumers face a potential loss of 1 ($= 20 - 19$, so the lowest loss size chosen by the two insurers has been 1); they can insure against this loss, by buying insurance from insurer 1 at a premium of 0.5 or at insurer 2 at a premium of 12.0. It is conceivable that in this period, insurer 2 will not attract any customers.

In each period, a insured consumer's earnings equal $W - R$ and the earnings of an uninsured consumer are W in case no loss occurs and $W - L$ in case of a loss. Insurer i's profits equal R_i times the number N_i of consumers that bought insurance from him minus L_i times the number of realized losses among his clientele. The subjects' earnings in Stage II are determined as follows. For consumer-subjects, one randomly selected Stage II period is paid out at the end of the experimental session. The insurer-subjects we decided on a different payment structure because payment based on a single period may result in insurers who systematically set their premium higher than the expected loss leaving the lab with a loss if in the chosen period, by pure chance, a high number of their customers happen to experience a loss. To avoid this, insurer-subjects were paid 10% of their accumulated profits.

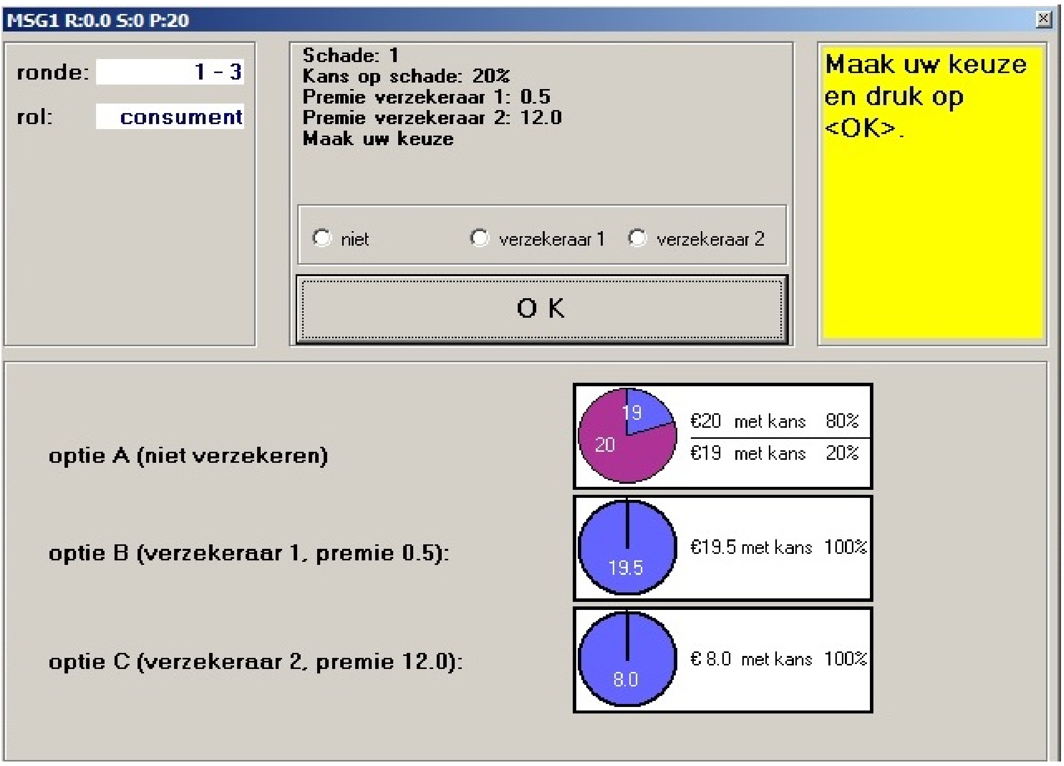

Figure 3: Example of a Stage II consumer decision screen in the duopoly treatment with $L_0 = 0$.

Table 3 gives a summary of different Stage II treatments.

Table 2: Summary of Stagee II treatments: The market insurance game

	Phase II Market insurance game					
tr.	# cons.	# insurers	decision variables	pot. loss uninsured	loss prob. (p)	# sessions
1	5	1	R	L	0.6	3
2	5	1	R, L	max(L, 0)	0.6	3
3	5	2	R_1, R_2, L_1, L_2	max(min$\{L_1, L_2\}$, 0)	0.6	2
4	5	2	R_1, R_2, L_1, L_2	max(min$\{L_1, L_2\}$, 20)	0.6	2

4 Data and experimental procedure

The experiment was conducted at the CREED experimental laboratory of the University of Amsterdam in June and November 2012 and April 2013. Sessions lasted between 1h25m and 1h50m. We ran a total of 16 sessions in which a total of 335 subjects participated in 54 separate markets. Of these subjects, 203 participated in one of four treatments described in the previous section: 60 (66) in the monopoly market with exogenous (endogenous) loss size and 35 (42) in the duopoly market with initial loss size $L_0 = 0$ ($L_0 = 20$). The other 132 subjects participated in a monopoly market with an exogenous (72) or endogenous (60) loss size but a lower loss probability of $p = 0.2$ instead of 0.6. These sessions, the results of which are reported in Section 5.3, were ran to see whether a different loss probability leads to qualitatively different outcomes. Table 3 gives a summary of the experimental design and the number of subjects in each treatment.

Students who showed up at the CREED-lab but could not participate (because multiples of 6 or 7 students were needed) were sent away after payment of a €7 show-up fee. The other subjects were paid one randomly chosen decision in Stage I and Stage II if they had the role of consumer in Stage II; subjects with the role of insurer in Stage II were paid out one randomly chosen decision in Stage I plus 10% of the accumulated profits in Stage II. We used a 1 : 1 conversion rate of euro's in

Table 3: Summary experimental design – Stage II

Potential loss (L) [1-15]	[16-30]	loss prob. (p)	insurers per market	markets	subjects cons.	ins.
12	20	0.6	1	1	5	1
20	12	0.6	1	2	10	2
4	12	0.6	1	2	10	2
4	16	0.6	1	1	5	1
16	4	0.6	1	1	5	1
8	20	0.6	1	1	5	1
20	8	0.6	1	1	5	1
12	4	0.6	1	1	5	1
max(L_1,0)		0.6	1	11	55	11
max(min$\{L_1, L_2\}$, 0)		0.6	2	5	25	10
max(min$\{L_1, L_2\}$, 20)		0.6	2	6	30	12
Total				**32**	**160**	**43**
4	16	0.2	1	2	10	2
16	4	0.2	1	1	5	1
8	20	0.2	1	1	5	1
20	8	0.2	1	1	5	1
12	20	0.2	1	2	10	2
20	12	0.2	1	2	10	2
4	12	0.2	1	2	10	2
12	4	0.2	1	1	5	1
max(L_1,0)		0.2	1	10	50	10
Total				**22**	**110**	**22**

the experiment to euro's paid.

Table 4 shows the average final Stage I + Stage II earnings per treatment. Insurer-subjects earn an average of €23.56 in the monopoly treatments and €26.18 in the duopoly treatments; consumers subjects earn on average €25.69 in the monopoly treatments and €29.06 in the duopoly treatments. These averages however conceal large between-treatment variation. For example, the table reveals that monopolistic insurer-subjects attain much higher earnings (€29.74) when they can decide on the premium ánd loss size than when they can only set the premium for a given loss size (€16.76). To the consumers' earnings, this does not seem to make any difference. Of course, theory predicts that a profit-maximizing firm should do at least as well when he has one extra parameter to influence. The summary statistics give a first indication that insurer-subjects are able to seize this opportunity and use it to attain higher profits.

A quick comparison between the consumer-subjects in the monopoly and duopoly treatments reveals that consumers seem to benefit from competition with their average earnings increasing with about €3.50. Interestingly, for final consumer earnings, it does not seem to matter whether the duopoly market initially started out as an insurance market ($L_0 = 20$) or not ($L_0 = 0$). For insurer-subjects, these two treatments lead to distinct differences in outcomes: the insurance market (where the uninsured will always face a potential loss of their entire endowment) proves a real boon (average earnings of €37.00) whereas average insurer earnings in the non-insurance market can be called modest (€13.19, and this includes their Stage I earnings). In the next section, we will study in greater detail the underlying behaviors that caused these outcomes.

Table 4: Subjects' final earnings (in €) ($p = 0.6$).

	mean	s.d.	min	median	max
			Monopoly		
Insurers	23.56	11.22	5.35	24.02	50.35
Consumers	25.69	8.78	8.00	26.00	40.00
$L_0 = 0$; *L fixed*					
Insurers	16.76	7.39	5.35	16.03	29.03
Consumers	25.69	9.75	8.00	26.00	40.00
$L_0 = 0$; *L choice*					
Insurers	29.74	10.69	12.25	29.00	50.35
Consumers	25.70	7.89	9.00	25.00	40.00
			Duopoly		
Insurers	26.18	18.18	4.80	17.91	70.31
Consumers	29.06	6.60	15.00	29.00	40.00
$L_0 = 0$					
Insurers	13.19	4.27	4.80	13.40	18.90
Consumers	29.04	6.19	19.00	29.00	40.00
$L_0 = 20$					
Insurers	37.00	18.31	14.90	34.50	70.31
Consumers	29.90	7.03	15	28	38

5 Experimental results

5.1 Risk preferences and profitable regions

First we have to ascertain for each individual market whether an insurer is able to make a profit and which (R, L)-combinations are most profitable. To this end, we consider every subject's Stage I decisions for all (R, L)-combinations where the probability of a loss when choosing option A is $p = 0.6$. Aggregating across subjects provides us with a map for the demand for insurance. This map is shown in Figure 4. In the map, the blue line running from $(2.4, 4)$ to $(12, 20)$ indicates the combinations for which a risk-neutral consumer would be indifferent between taking insurance or staying uninsured. To the left of this line, she would choose to insure, to the right to stay uninsured. The squares with the numbers in the grid indicate the actual decisions of subjects in the risk elicitation stage. The number presents how many (out of 335) chose to take insurance and the more subjects take insurance the greener the square is. For instance, in case the choice was to loose 16 of the endowment of 20 with 60% probability or to pay a premium of 12 to have 8 for sure, 187 subjects chose the safe option. The map furthermore shows the isoprofit curves of a monopolistic insurer who would serve the entire (hypothetical) market of 335 subjects.

There are two important points to notice from this map. First, most of our subjects indeed show risk-averse behavior with e.g. 200 or more deciding to buy insurance at a premium 8 to be safeguarded against a 60% probability to loose 12. Second, a profit-maximizing insurer in this market would do best if he would set the loss size close to or at the maximal level of 20 and would offer insurance at a premium of about 14-16. At a premium of 14, 222 subjects would take insurance and his expected profits would equal $222 \times (14 - 0.6 \times 20) = 444$; setting a loss size of 16 and a premium of 12 would be even slightly better, with expected profit equal to $187 \times (12 - 0.6 \times 16) = 448.8$. So, the actual behavior of consumers in this

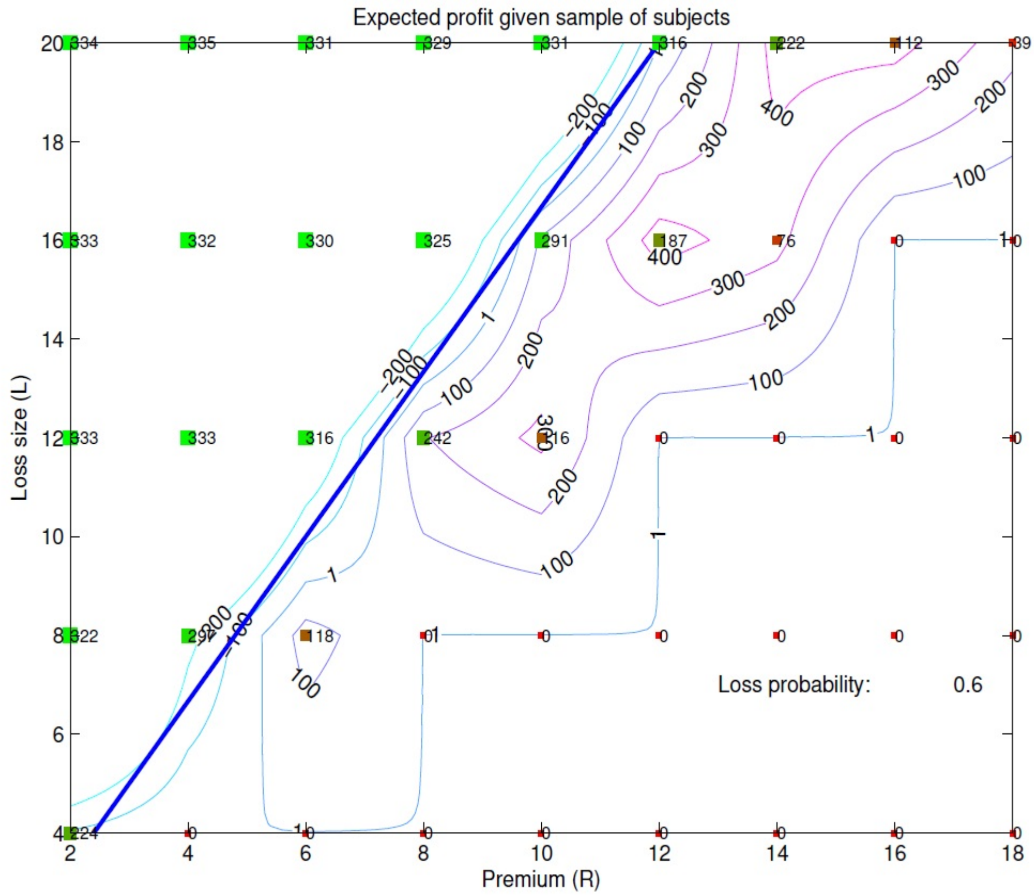

Figure 4: Aggregated decisions in the risk elicitation stage and isoprofit curves for a hypothetical insurer who would serve the entire market.

experiment is in line with the theoretical argument posed in propositions 1 and 2. The question is whether subject with the role of insurer in the market insurance stage are able to uncover the particular isoprofit map of their market and set the loss size and premium charged to the profit-maximizing level. This question is answered in the next section.

5.2 The market insurance game

5.2.1 The monopoly case

Figure 5 also shows isoprofit curves but now for one particular market in treatment #2, the monopoly with endogenous loss size. Since each insurer only has 5 consumers in his market, he can have a "tough" market with relatively many risk-neutral or even risk-loving consumers who make it hard on him to make a profit. Similarly, an insurer-subject can be fortunate to end up in an "easy" market with consumers who are eager to buy insurance. The market depicted in Figure 5 does not seem to tough, with the region in which maximal expected profits are obtained being comparable to the one in Figure 4.

The squares in the figure denote the premium-loss size combinations that were actually offered by this insurer to his consumers in the market stage of the game. The size of the squares increases in later rounds and for every fifth period, the square is numbered. Figure 5 shows that this particular always sets loss sizes and premiums such that his expected profits are positive (that is, the area to the right of the solid blue line). Moreover, after some experimenting, this insurer moves into the profit maximizing region and after period 20, he always sets the loss size at either 19 or 20 and the premium to insure against this loss at 13 or 14. That an insurer is well able to find out the profit maximizing combination of two choice variables is a remarkable achievement, especially since they do not know the consumer-subjects with whom they form a group nor their risk-profile. Levitt (2006) shows for a real-life situation that firms can have problems in selecting the profit-maximizing price.

Figure 6 shows the average per period earnings of the insurer-subjects in the monopoly treatments with given and endogenous loss sizes. The figure reiterates our preliminary finding from Table 4 that in general, insurers know how to utilize the extra decision variable to increase their profits in the treatment where they decide as well on the loss size that the uninsured will face. The figure also shows that in

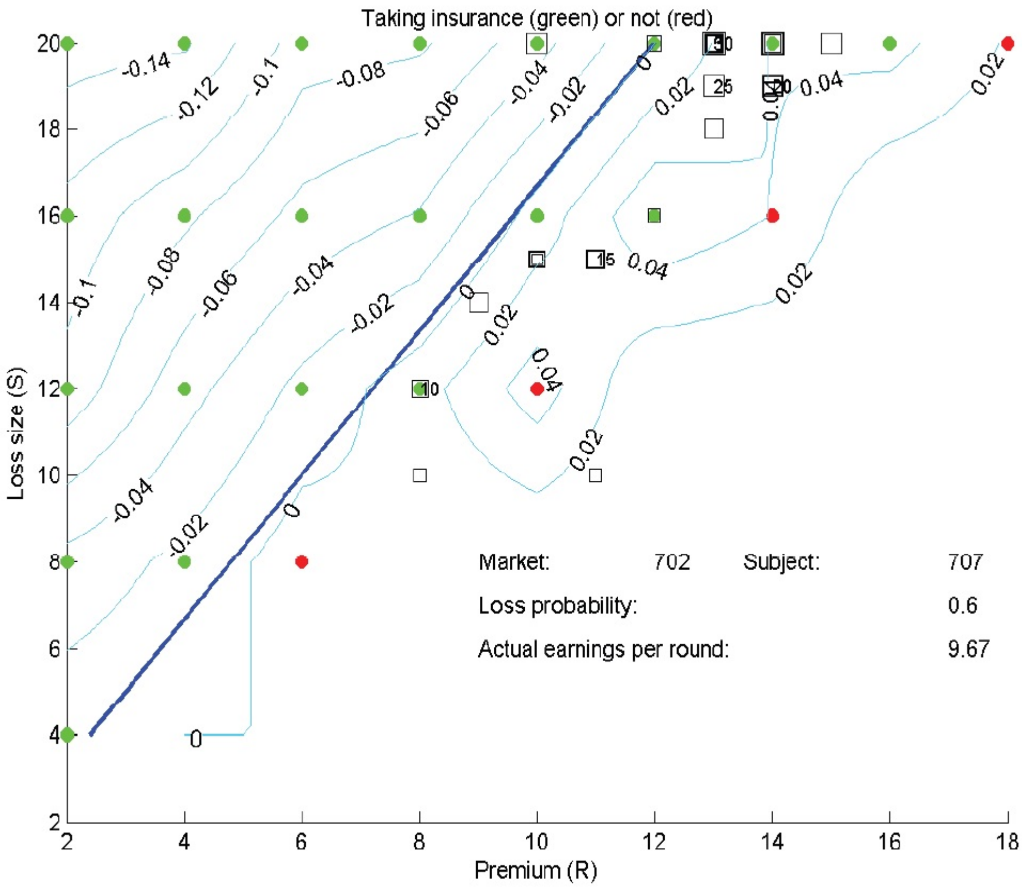

Figure 5: Isoprofit curves for an monopolistic insurer in one of the markets in treatment #2, the monopoly market with endogenous loss size ($p = 0.6$).

Notes: The squares indicate (R, L)-combinations offered by the insurer in the market, the size of the squares is increasing with the periods of the game. The circles denote this insurer's decisions in the risk elicitation stage, with green (red) circles denoting taking (no) insurance. This insurer showed risk-averse behavior in the first stage.

both treatments the average earnings are considerably higher in situations where the loss size is set at a high level of 12 or higher. The main reason for the higher insurer earnings in the endogenous loss size treatment is that they shift the loss size to this more profitable region.[6]

[6]In the exogenous loss size monopoly treatment, we have 75, 30, 90, 30 and 75 observations of loss sizes equal to $4, 812, 16$ or 20, respectively. In the endogenous loss size treatment, these numbers are 0, 5, 45, 45 and 103 (neglecting chosen loss sizes other than these five integer numbers).

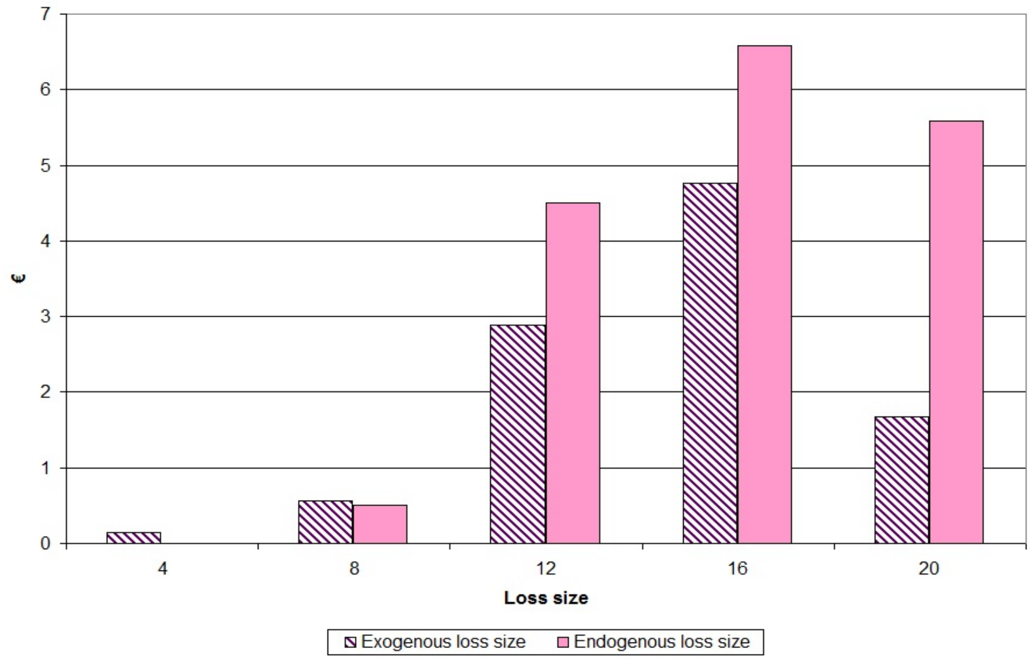

Figure 6: Average earnings insurer in the monopoly treatment for given and endogenous loss sizes.

5.2.2 The duopoly case

For the duopoly case, we derived a clear theoretical prediction (see Table 1): independent of the initial loss size, the introduction of competition should reduce both the premium and the loss size to zero. However, since this situation directly threatens the *raison d'être* of the insurance companies, it is not clear whether this is the situation we will observe in practice. Looking at Figure 7, we can imagine that insurers would compete in premiums but not in loss size; that is, the observed offers would not move to the down-left corner with low loss sizes and low premiums but to the point at the top of the graph where the horizontal $L = 20$ intersects with the solid blue line.

Figure 7 shows what happened in a typical stage $L_0 = 0$ insurance market. We observe that the chosen loss sizes are mostly in the range 7-10 with the corresponding

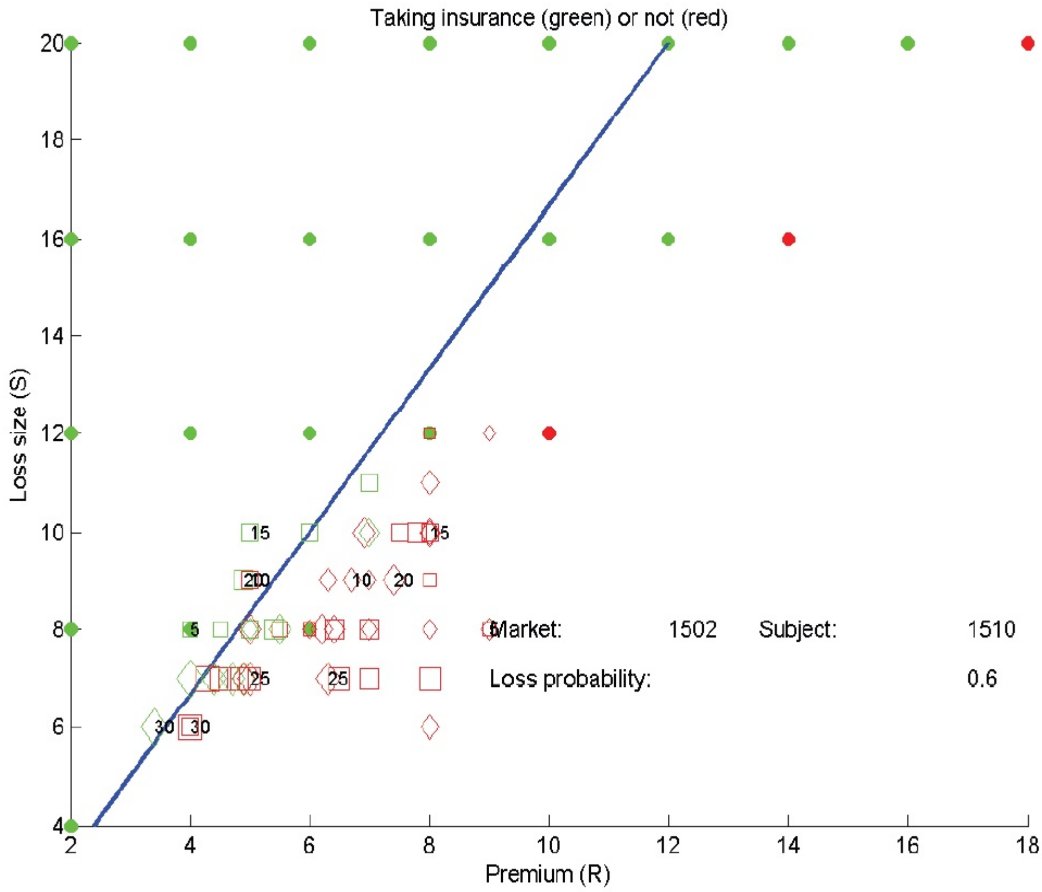

Figure 7: Decisions by insurer-subjects in one of the markets in treatment #3, the duopoly treatment with initial loss size $L_0 = 0$ and $(p = 0.6)$.

Notes: The squares and diamonds indicate (R, L)-combinations offered by the insurers in the market, the size of the squares and diamonds is increasing with the periods of the game. The circles denote one of the consumer's decisions in the risk elicitation stage, with green (red) circles denoting taking (no) insurance. When this consumer accepts the offer of one of the insurers in the market insurance stage, the corresponding square or diamond is green, otherwise it is colored red.

premiums charged in the range 5-8. Remarkably, competition seems to lead our insurer-subjects now and then to choose (R, L)-combination to the left of the blue line, that is, they offer an insurance policy whose expected profit is negative. This is one explanation for the low insurer earnings in this treatment shown in Table 4. The consumer whose decisions are shown in the figure is only happy to buy this cheap insurance (green squares and diamonds).

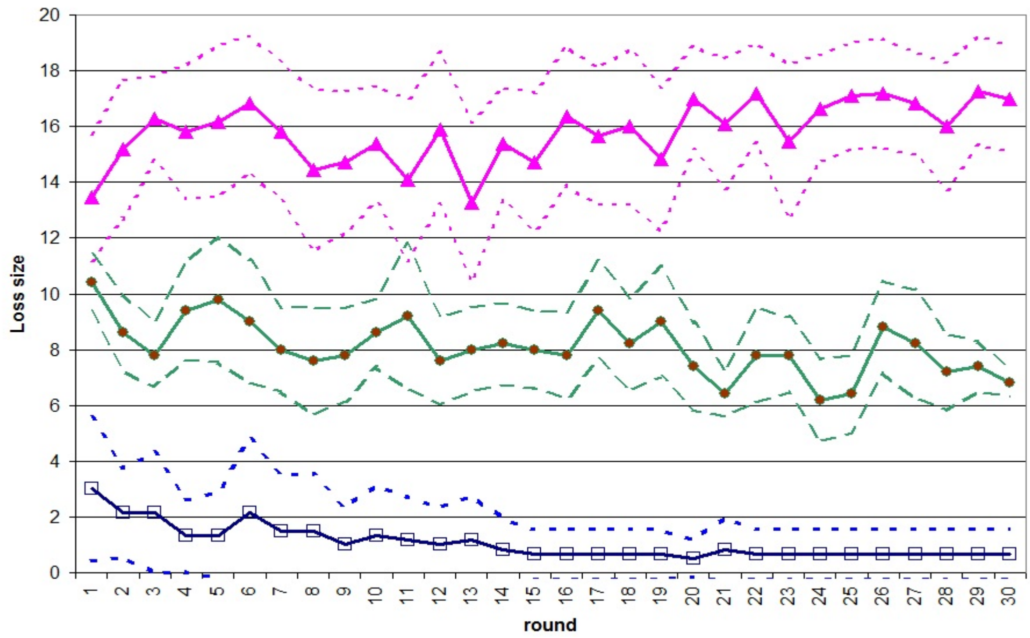

Figure 8: The average potential loss size uninsured consumers face in the monopoly (triangles) and duopoly treatments ($L_0 = 0$: circles). For the duopoly treatment with $L_0 = 20$ (squares) the average loss size insurers *pay* to the service suppliers in case of a loss among their customers. The dashed lines depict the mean +/− two standard errors. **Note:** In the duopoly treatment with $L_0 = 20$ the loss size for the uninsured is always 20 and therefore not shown.

Figure 8 contains the development over time of the potential loss faced by the uninsured in the monopoly and duopoly treatments with $L_0 = 0$ (triangles and circles) and the the average loss size insurers *paid* by the insurers to the service suppliers in the duopoly treatment with $L_0 = 20$. The figure confirms that the introduction of competition greatly reduces the risk of being uninsured. Compared with the monopoly market, competition does lead to lower potential loss sizes and insurance premiums but the loss sizes to not reach the predicted equilibrium value of 0 with potential loss size of the uninsured hovering around 8. The question is whether this is due to the effect specific for the $L_0 = 0$ treatment in which low loss sizes let the insurance market disappear or that this is something we also observe in the duopoly market with initial loss size $L_0 = 20$. The figure shows that in the $L_0 = 20$ duopoly treatment, the circumstance that the uninsured will face a potential loss of 20 independent of the amount the duopolists pay to a hypothetical service supplier quickly leads the average price the insurers pay to the service supplier (that is, their costs of coverage) to drop to values near zero.

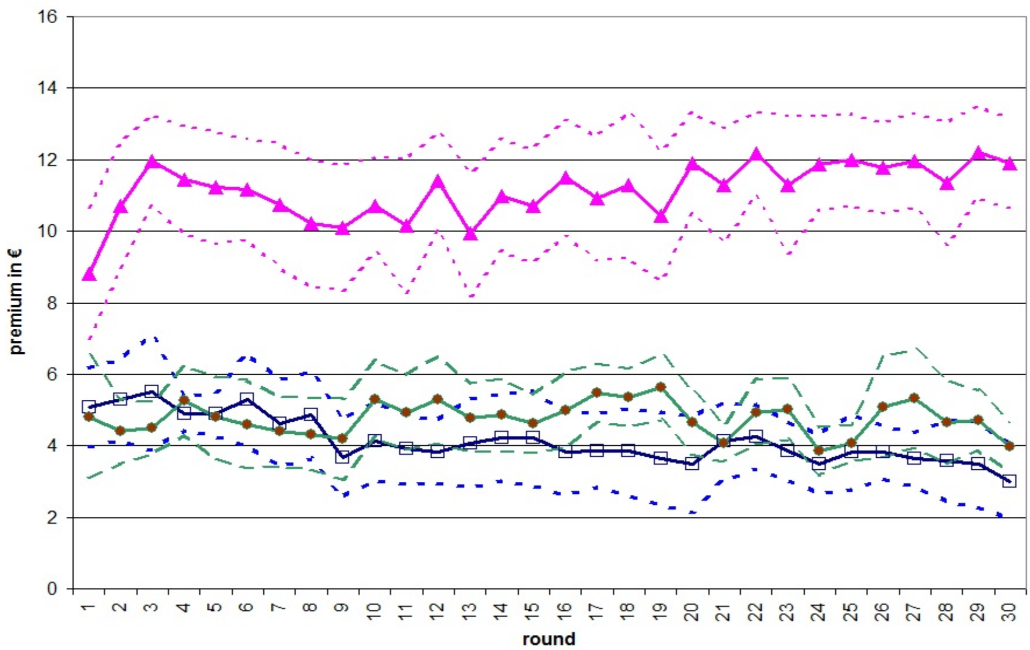

Figure 9: Average premium set by insurers in the monopoly (triangles) and duopoly treatments ($L_0 = 0$: circles; $L_0 = 20$: squares). The dashed lines depict the mean $+/-$ two standard errors.

Do these lower costs also translate into lower premiums charged to the consumer-subjects? Figure 9 answers this question: although the premium level in both duopoly treatments are clearly much lower than in the monopoly treatment, they stay significantly above the predicted equilibrium value of 0. Because of the positive premiums and the low cost paid to service suppliers, insurers attain high profit-margins in the $L_0 = 20$ duopoly, reflected in high earning (Table 4). One of the most interesting aspects of Figure 9 is that consumers in the duopoly market that starts out as a non-insurance market ($L_0 = 0$) not only end up paying a positive premium but they also pay on average slightly but significantly higher premiums for their insurance than the consumers in the other duopoly market (according to Table 4 their final earnings are also slightly less in the former treatment). This slight but significant upward tendency in the premium can be ascribed to the demand effect that is the sole difference between the $L_0 = 0$ and the $L_0 = 20$ duopoly.

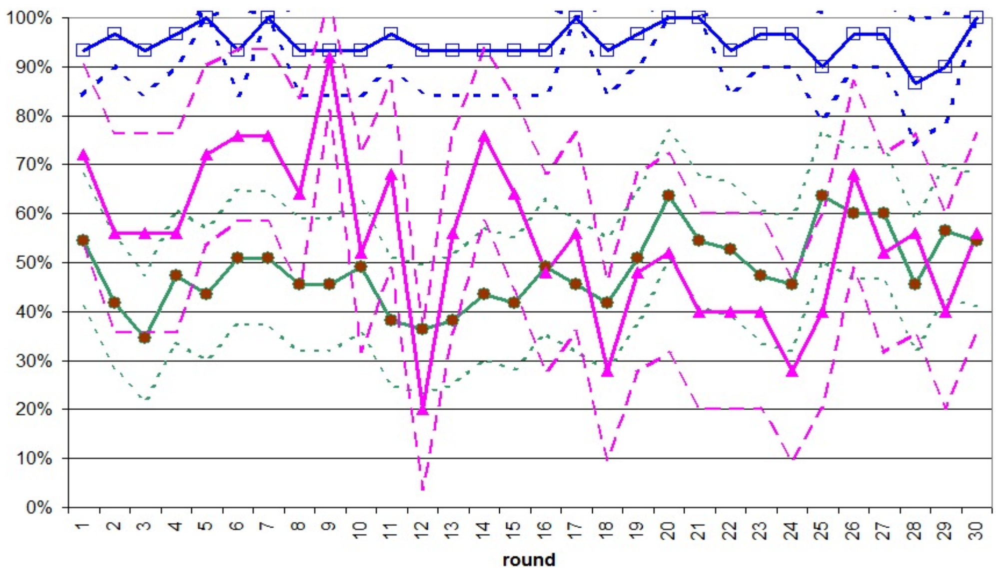

Figure 10: Average percentage of all consumers that decides to buy insurance in the monopoly (triangles) and duopoly treatments ($L_0 = 0$: circles; $L_0 = 20$: squares). The dashed lines depict the mean +/− two standard errors.

Besides the slightly different premiums charged, the outcomes in both duopoly markets widely differ in the percentage of consumers that chooses to take insurance. Figure 10 shows that in the $L_0 = 20$ duopoly, almost all consumers buy insurance from one of the two firms. The reason for this of course is the high risk the uninsured face in this treatment. In the $L_0 = 0$ treatment, on average about half of the consumers seeks coverage against the potential loss of being uninsured. This number is not very different from the average percentage of insured consumers in the monopoly treatment.

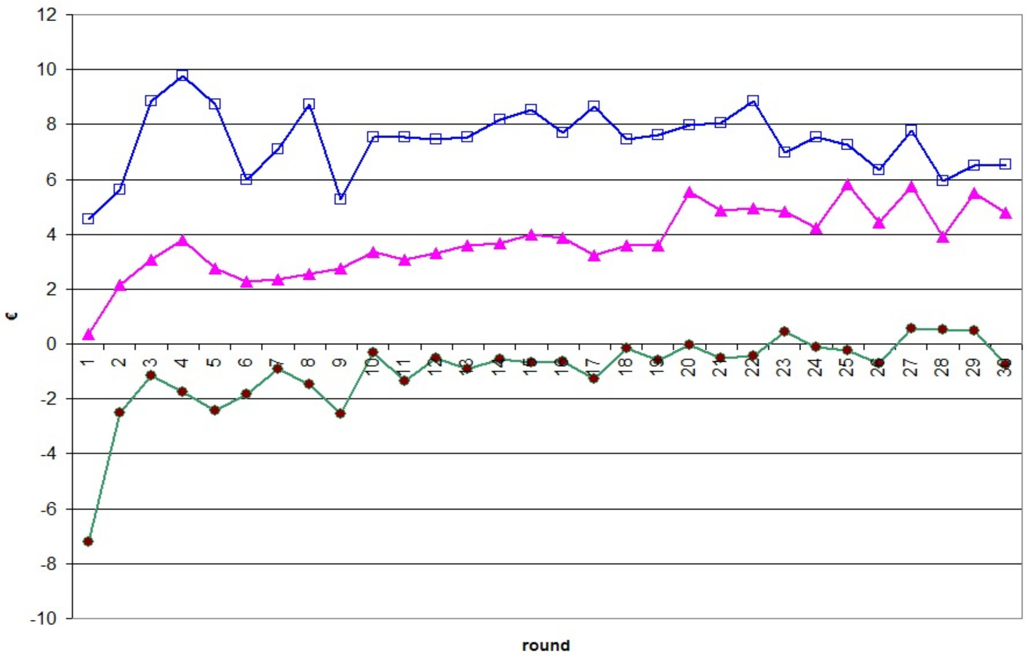

Figure 11: The average expected profits insurers would earn given their offers and the consumers' decision to insurer in the monopoly (triangles) and duopoly treatments ($L_0 = 0$: circles; $L_0 = 20$: squares). The expected profits are calculated assuming that each of the consumers experiences a loss with probability $p = 0.6$.

Finally, Figures 11 and 12 show the average expected profits of insurers and the expected earnings of consumers, respectively, in the different experimental markets. The plotted profits and earnings are "expected" in the sense that we evaluate in each period the effect of an individual's decisions on the expected outcomes, so before nature actually draws whether or not a loss materializes. In this way, the figures neglect the noise caused by the random loss draws of nature. Figure 11 shows that insurer-subjects do benefit from the absence of competitors or the circumstance that uninsured consumers lose their entire endowment. The figure also shows that insurers have a hard time to make a profit in the duopoly market where the uninsured

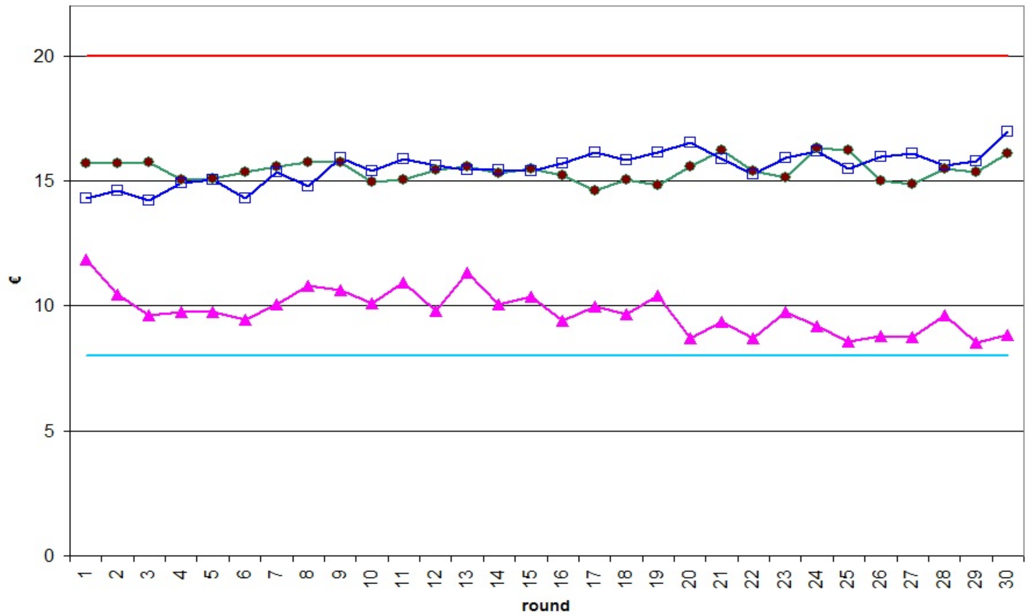

Figure 12: The average expected earnings by consumers given their actual decisions to buy insurance in the monopoly (triangles) and duopoly treatments ($L_0 = 0$: circles $L_0 = 20$: squares). The expected profits are calculated assuming that each of the consumers experiences a loss with probability $p = 0.6$.

face a potential loss equal to the minimum of the loss sizes set by the two insurers. In fact, the insurers incur a net expected loss in the first 17 periods, this because they offer insurance at premium levels below the level needed to cover the expected cost.

Figure 12 shows that in the monopoly treatment (where the initial loss size is $L_0 = 0$), consumers are much worse off when an monopolistic insurer is presented: this insurer inflates the potential loss size to values close to the consumers' endowment of 20. He sets the premium at a high level and in the final rounds, the consumer's expected profits are barely higher than 8, the level she would achieve in case no insurance would be offered to protect against a potential loss of 20 that would materialize with probability $p = 0.6$ (the solid light blue line).

In case the potential loss to the uninsured is 20, the consumers are clearly better of when there is a competitive market for insurance: the insurers (who have all the bargaining power) negotiate great deals with the service supplier and transfer part of this advantage to their insurees in the form of lower insurance premiums. Our results thus show that for high risks (expensive services), having a competitive insurance market with the insurers having bargaining power increases consumer welfare.

On the other hand, the figure shows as well that in the duopoly where, absent the insurers, there is no loss, consumer earnings are not higher than in the other duopoly market, if anything, they are slightly lower. For low risk (inexpensive services), our experimental evidence thus shows that insurers are able to turn them into higher risks for which consumers seek coverage. This barely enables the insurers to make a profit, but it harms the consumers by reducing their surplus from where it would be (the solid red line) without the insurers present.

5.3 Lower risk potential losses

[TEXT TO BE ADDED]

6 Summary and discussion

[TEXT TO BE ADDED]

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Table 5: Experimental outcomes on the expected loss sizes L and premium R set by the insurer (risk-averse consumers, loss probability $p = 0.6$).

	Monopoly		Duopoly	
initial loss size	L	R	L	R
$L_0 = 0$	15.80	11.14	8.09	4.76
$L_0 = 20$	X	X	1.08	4.14