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 Manipulation and Competition:  
 Experimental Evidence**

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# **(Non-)Insurance Markets, Loss Size Manipulation and Competition: Experimental Evidence**

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**Abstract**

The common view that buyer power of insurers may effectively counteract provider market power critically rests on the idea that consumers and insurers have a joint interest in extracting price concessions. However, in markets where the buyer is an insurer, the interests of insurers and consumers to reduce prices may be importantly misaligned. The positive dependence between loss size and the insurer's expected profits limits the insurer's incentives to reign in loss sizes; in markets with small initial loss sizes, insurers may try to raise these in order to create demand for insurance.

After having defined insurance and non-insurance markets based on the initial loss size, we develop theory to show that insurers with buyer power have incentives to create insurance markets. Insurer competition will push their profits to zero but markets do not return to the initial non-insurance state. This constitutes a welfare loss. We design experimental insurance markets to test our theory and find support. Monopolistic insurer-subjects in non-insurance markets increase loss sizes to establish insurance markets. Insurer competition eliminates profits but not the loss size to uninsured consumers. This provides an additional reason to be careful in granting insurers buyer power.

*JEL classification:* C92, D81, G22, I11, L13

*Keywords:* insurance markets, risk elicitation, experiment, buyer power

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# 1 Introduction

With a few exceptions, market power is considered to have a detrimental effect on consumer welfare. One suggested exception is that in markets with supplier concentration, granting buyers countervailing power enables them to extract discounts from these suppliers. Consumers benefit when these negotiated discounts are passed on to them. This argument has been used in product markets but also in insurance markets where the buyers are insurers who bargain with service suppliers such as hospitals about the price of treatment. However, in markets where the buyer is an insurer, the interests of insurers and consumers to reduce input prices may be importantly misaligned. Given risk-averse consumers, the positive dependence between the insurer's expected profits and the loss size consumers face puts natural limits on the insurer's incentives to pursue lower loss sizes. To the contrary, insurers may try to raise loss sizes in order to expand the market for insurance. This positive dependence of consumer demand on input prices distinguishes markets where the downstream firm is an insurer from other product markets where demand is a function of final-good prices only.

The consequences of buyer power have been studied theoretically and empirically for general retail markets where downstream buyers negotiate prices with upstream suppliers (Chae and Heidhues, 2004; Inderst and Wey, 2007, and Ellison and Snyder, 2010) and for the specific case where insurers negotiate with service suppliers such as hospitals (Sorensen, 2003; Lakdawalla and Yin, 2015; Trish and Herring, 2015; Ho and Lee, 2013). These studies illustrate that the relation between service supplier concentration and insurer countervailing power on negotiated prices, premiums and welfare is complex.<sup>1</sup> Studying the introduction of Medicare Part D, Lakdawalla and Yin (2015) find that insurer bargaining power leads to significant price reductions but only when the upstream manufacturers face sufficient competition in their product market. Trish and Herring (2015) find that health insurance premiums are lower when insurer concentration is high in markets relevant to insurer bargaining with hospitals, but higher when concentration is high in the markets where the insurance is sold. Ho and Lee (2013) report mixed effects of the removal of one large health insurer on the premiums set by insurers with negotiated prices

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<sup>1</sup>Snyder (2008) summarizes the literature on countervailing power since Galbraith (1952) and concludes "The concept of countervailing power was controversial in Galbraith's day (...), and continues to be so today. Formalizing the concept is difficult because it is difficult to model bilateral monopoly or oligopoly, and there exists no single canonical model."

increasing or decreasing up to 15% across markets. An important common feature of all these studies is that they take the risk and, consequently, the demand for the insurance as given and focus on how concentration on either the supplier and/or the buyer side influences the outcome of the bargaining game that unfolds.

We instead investigate insurers' incentives to engage in loss prevention in contexts where these activities potentially have a negative impact insurance on demand. Take the extreme case of an insurer with full buyer power who very successfully reduces the potential loss consumers face. He possibly erodes his own market because consumers may not bother to buy insurance when the downside is negligible. Because of this mechanism, the interests of insurers and consumers may be importantly misaligned. In particular, in markets with small initial loss sizes the insurer has incentives to use his buyer power to create an insurance market by increasing the potential loss.

Attention for this dimension of insurance markets has been scant, with the exception of the theoretical contributions by Schlesinger and Venezian (1986, 1990). They explicitly examine the insurers' incentives to engage in loss prevention and loss reduction, which they define as reducing the probability of a loss and reducing the severity of any loss that does occur, respectively. Despite the conclusion that for loss reduction "the incentive is to reduce the size of small losses while simultaneously increasing the size of large losses"<sup>2</sup>, in both papers they mostly ignore the possibility that an insurer would act to the detriment of consumers, arguing that: "*... such action is likely to meet with resistance from the individual (...) as well as from insurance regulators.*"<sup>3</sup> Given the possibilities to cover up such activities, we are less sanguine about this possibility.

Central in our analysis is a categorization of markets into insurance and non-insurance markets based on what we call the initial loss size. A market's initial loss size is the loss size that would prevail without insurer intervention. We define a market 'an insurance market' if the initial loss size is sufficiently large for risk-averse consumers to prefer buying insurance over staying uninsured when the insurance is priced at actuarially fair rates. On the other hand, a 'non-insurance market' is characterized by initial loss sizes sufficiently small such that, even if offered at actuarially fair rates, risk-averse consumers do not bother to buy coverage because the transaction cost of taking out insurance exceeds the benefits of coverage.

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<sup>2</sup>1990, p. 83.

<sup>3</sup>1986, p. 232.

We make two main contributions. First, we formulate (Section 2) the distinction in insurance and non-insurance markets in a state-preference framework (Arrow, 1964). This representation allows us to build the argument that in non-insurance markets, insurers with buyer power have incentives to increase the initial loss size in order to create an insurance market. We also show that competition between insurers erodes their profits by pushing premiums to the actuarially fair rate. However, the market does not return to the initial state where potential losses are sufficiently small for consumers not to buy insurance; the transformation into an insurance market therefore results in a irreversible welfare loss. This is different in markets that are insurance markets by nature. In those markets, competition also erodes insurer profits, but in their quest for lower premiums insurers will push the prices of suppliers all the way to marginal cost, greatly benefiting insurees.

The second contribution is that we take our theoretical predictions to the lab. We report the results of a number of experiments designed to investigate under which conditions insurers can tweak the risk to which the uninsured are exposed to their own benefit but possibly to the consumers' disadvantage. The risk manipulation can in principle take either the form of increasing either the probability of a loss or the size of a potential loss; in this paper we focus on the latter. For our purposes, one obvious advantage of conducting an experiment over analyzing empirical data is that we can observe and control whether a market constitutes an insurance market by setting the initial loss size. We set up markets with five consumers and one (monopoly treatment) or two (duopoly treatments) insurers. The monopoly treatment (MONOP-NI) is used to examine whether the extent to insurer-subjects with market power seize the opportunity to increase the potential loss to which consumers are exposed. The duopoly treatments aim to study the premium and loss size setting strategy of competing insurers in insurance (DUOP-I) and non-insurance (DUOP-NI) markets. This allows us to test our theoretical prediction that competition will be more beneficial for consumers in insurance markets than in non-insurance markets.

In each period, the consumer-subjects 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 a consumer experiences a loss in that period. In the duopoly treatments with seven participants, two subjects have the role of insurer and the remaining five

subjects can select one of these insurers to buy insurance or decide to go uninsured. We sidestep issues of adverse selection and moral hazard by assuming throughout that all agents have perfect information.

Our main experimental findings are as follows. First, insurer-subjects in the non-insurance monopoly treatment MONOP-NI are well able to select the loss size-premium combination that maximizes their profits conditional on the risk-preferences of the consumer-subjects assigned to their market. The loss size is on average set at €16.44 and, with a loss probability of 60%, the accompanying premium of on average €11.59 more than compensates for any expected losses. In this market, consumers earn an average surplus of €9.22. Second, competition between insurers in the non-insurance duopoly market DUOP-NI wipes out insurer-profits, reduces the average loss size to €4.99 and increases average consumer surplus to €15.36. However, we do not observe a reversion to the initial non-insurance state where consumers do not face any loss: the average loss size uninsured consumers face is a still sizeable €7.71 which can be attributed to the threat to insurers that their market is eaten away if loss size become too small. In fact, with €3.54, the average premium faced by consumers in the duopolistic insurance market DUOP-I is even somewhat lower (significant at the 10% level) than in DUOP-NI and with €16.21 average consumer surplus is not significantly higher. In sum, if it is left to insurers, the distinction between non-insurance and insurance markets disappears and all markets become insurance markets, independent of whether the insurers face competition.

Beside these two main contributions, our study also contributes to the research on the stability of risk preferences across decision contexts (Barseghyan *et al.*, 2011; Einav *et al.*, 2012). Our design with non-automated live-buyers necessitates that we meticulously account for consumer risk preferences to rule out that between-treatment heterogeneity in preferences is driving our results.<sup>4</sup> To accomplish this, we split the experiment in two stages with the actual market game being preceded by a risk-elicitation stage. We elicit and estimate risk-preferences using the multiple price list methodology that has also been applied by Von Gaudecker *et al.* (2011). A comparison of the first (risk-elicitation) and second (market game) stage choices of consumer-subjects allows us to address the question whether individuals exhibit the same risk attitudes when they are put in a strategic market context instead as when they are submitted to an individual risk-elicitation task. We find that the elicited risk attitudes predict a consumer's

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<sup>4</sup>This is in particular an issue because our experimental markets are small, having five consumers in each market; an insurer who is randomly assigned more risk-averse consumers is able to attain higher profits.



insurance choices in a market context reasonably well but that they exhibit some inclination to make less averse choices when the insurance market is competitive. The latter may be because consumers have an expectation that in a competitive environment playing hard to get is more likely to result in receiving more favorable offers in future periods.

## 2 Theoretical Framework

Figure 1 presents in state-claims space the decision-problem of a monopolistic insurer facing a risk-averse consumer with a strictly concave utility function  $U(\cdot)$ ,  $U' > 0$  and  $U'' < 0$ .<sup>5</sup> There are two possible states of nature, a good state  $W_g$  and a bad state  $W_b$ , distinguished by whether the consumer with initial wealth  $W$  experiences a loss of size  $L$  or not. Let  $p$  denote the probability of a loss (“bad state”). The 45° line is the certainty line comprising the collection of contingent claims with equal consumption in both states of the world. Indifference curves in state-claims space are defined as the set of claims for which a consumer’s expected utility  $V(W_g, W_b) = pU(W_b) + (1 - p)U(W_g)$  is constant. These indifference curves are convex for risk-averse consumers.<sup>6</sup>

When the initial loss size  $L_0 = 0$ , consumers keep their initial wealth  $W$  in both states, that is, they face the initial state claim  $(W, W)$  shown as point **D** in the figure. This clearly is a non-insurance market. If the consumer faces a positive transaction cost  $c$  in buying insurance, the market will continue to be a non-insurance market for all initial loss sizes  $L_0$  for which the certainty equivalent  $CE(L_0)$  is such that  $U(CE(L_0)) = U(W - pL_0 - c) \leq pU(W - L_0) + (1 - p)U(W)$ , the left-hand side of this inequality corresponds to point **M<sub>S</sub>** in Figure 1, the right-hand side to point **L<sub>S</sub>**. For  $\pi_{M_S} < c$  the market is a non-insurance market for all initial loss sizes  $L_0 \leq L_S$  (all points on the vertical line between **D** and **B**) because the transaction cost exceeds a monopolistic insurer’s profit margin.

Figure 1 immediately shows that the monopolistic insurer has strong incentives to push the initial state claim towards  $(W, W - L_L)$  (point **A**) with corresponding expected profits  $\pi_{M_L}$  by increasing the loss size to  $L_L$ , the exogenously defined maximum loss size. We state this as a proposition the formal proof of which is given in the appendix:

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<sup>5</sup>For ease of exposition, we assume that consumers have homogenous risk preferences. In the analysis of the experimental data we relax this assumption and explicitly allow for the possibility that the consumers the insurer faces in his experimental market may have heterogeneous risk preferences.

<sup>6</sup>This immediately follows from the marginal rate of substitution being equal to  $-(1 - p)U'(W_g)/(pU'(W_b))$ .

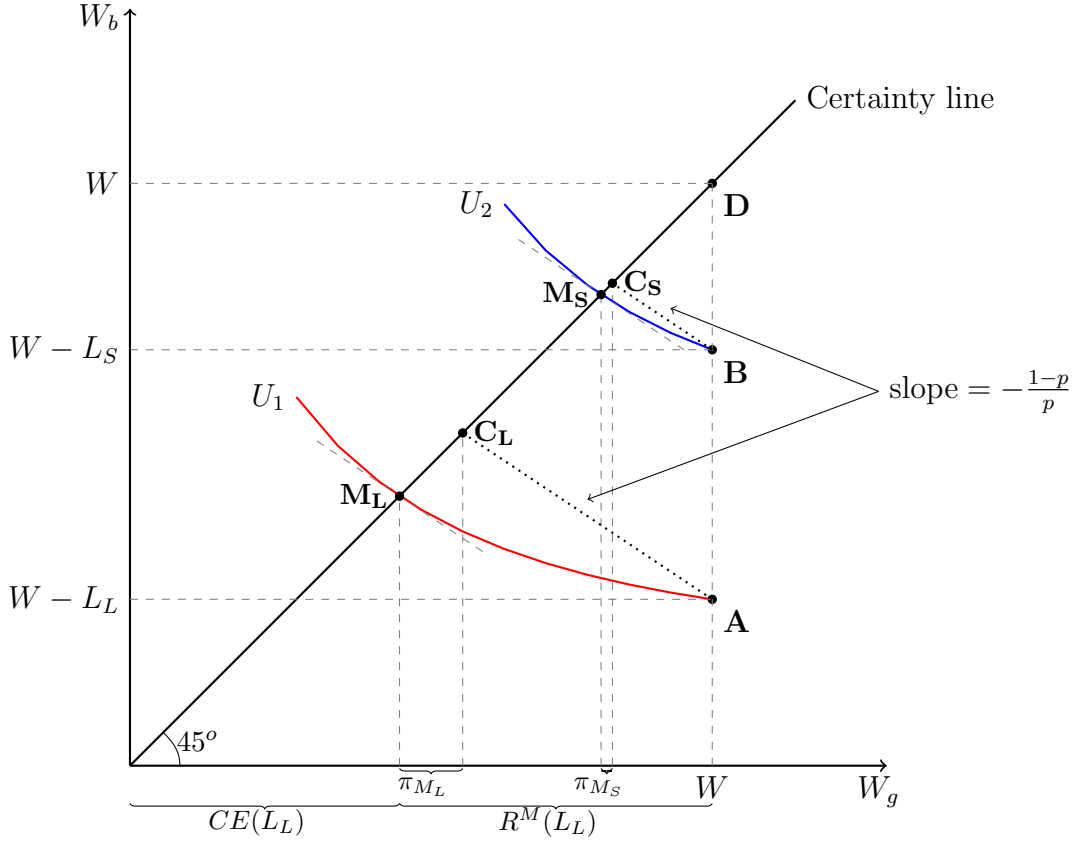


Figure 1: Small and large potential losses in the state-claims model.

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

In this case, offering insurance at premium  $R^M(L_L)$  makes the consumer indifferent between buying insurance (contingent claim  $\mathbf{M}_L$ ) and staying uninsured (contingent claim  $\mathbf{A}$ ). Without countervailing bargaining power towards suppliers, the insurer's expected profits are  $\pi_{M_L}$  on each policy sold. With countervailing buyer power, the insurer may extract price concessions from suppliers such that his direct claims costs are less than  $L_L$  in case one of his clients experiences a loss. This may further increase his profits: in the most extreme case he negotiates a price of 0 such that his per-client profits equal the premium paid  $R(L_L)$ . It is of key importance for the insurer that this negotiated deal is not available to the non-insured, because otherwise the contingent claim of the uninsured returns to point  $\mathbf{D}$  and the insurance market is fully eroded. In case of exclusive deals and no competition in the insurance market, the insurer has no incentive to pass the negotiated discounts to its insured consumers, such that consumers

remain indifferent between buying insurance (point  $\mathbf{M}_L$ ) or not (point  $\mathbf{A}$ ).

In sum, when the initial loss  $L_0 = L_L$ , the presence of a monopolistic insurer does neither benefit consumers nor wreak havoc on their welfare. When the initial loss size  $L_0 < L_L$ , consumers may experience a loss in welfare because of the attempts by insurers to increase the loss size, possibly to its maximum.

## 2.1 Competition in the Insurance Market

How does competition in the market for insurance affect these outcomes? Absent buyer power, insurers take the initial state claim  $(W, W - L_L)$  as given and will offer insurance at competitive prices. That is, consumers can exchange one unit of wealth in good times for one unit of wealth in bad times at the actuarially fair ratio of  $(1 - p)/p$ . In Figure 1, these fair price lines are shown as dotted lines. In an insurance market with  $L_0 = L_L$ , consumers benefit from competition because they can now reach the contingent claim  $\mathbf{C}_L$  instead of  $\mathbf{A}$ .

What if the insurers compete for consumers but each have full buyer power towards suppliers? Is this the best of worlds that brings consumers back to point  $\mathbf{D}$ ? The answer is that this critically depends on whether negotiated discounts also become available to uninsured consumers. If not, uninsured consumers continue to face a loss  $L_L$  while insurers have strong incentives to negotiate discounts to enable them to profitably undercut the premium of their competitors. In case the supplier has zero marginal cost and the insurer does not have any variable cost, competition will push the contingent claim offered by insurers to point  $\mathbf{D}$ . All consumers will choose to buy insurance at zero premium while the insurers' profits equal zero. We again state this association between the level of competition in the insurance industry and insurance premiums as a formal proposition:

**Proposition 2.** *Let  $c$  be the transaction cost a consumer experiences when buying insurance. For given  $c$  let  $\underline{L}(c)$  be the potential loss for which a consumer is indifferent between buying insurance at the actuarially fair rate or remaining uninsured. When two insurers compete in premiums  $(R_1, R_2)$  and loss sizes  $(L_1$  and  $L_2)$ , in equilibrium  $R_1 = R_2 = L_1 = L_2 = 0$  and  $E[\pi_1(L_1)] = E[\pi_2(L_2)] = 0$ , for any potential loss  $L \geq \underline{L}(c)$  faced by the uninsured.*

However, if the negotiated deals are also available to the non-insured (i.e.  $L = \min\{L_1, L_2\}$ ), competitive insurers with buyer-power will only push back the loss size to  $L_1 = L_2 = \underline{L}(c)$ . Lower loss sizes would erode the insurance market because consumers would no longer bother to

buy insurance since the benefits to not exceed the transaction cost  $c$ . In equilibrium, consumers are indifferent between buying insurance (point **C<sub>S</sub>**) or not (point **B**) while insurers' profits again equal zero. Notably, the market in this case remains an insurance market and consumers are worse off than at point **D**. Only when the transaction cost  $c = 0$ , consumers will take out insurance for any small risk. In that case  $\underline{L}(0) = 0$  and the equilibrium will be similar to the exclusive negotiated deals case with insurers offering contingent claim **D**.

## 2.2 An Illustrative Example

As indicated, transitions of markets from non-insurance markets are hard to identify in practice because the initial loss size  $L_0$  is not observed. To illustrate how this mechanism may function, we provide a stylized example how efforts to counteract supplier market power with insurer market power may backfire.

Consider a product market with a monopolistic firm that supplies two vertically differentiated versions of a particular product, a version of quality  $q_L$  and a second version of  $q_H$ . The unit cost of production of each version is constant but higher for the high quality version,  $c_L < c_H$ . Consumers receive a surplus of  $U = \theta q - x$  if they buy a product of quality  $q$  at price  $x$  and 0 otherwise.<sup>7</sup> Consumers are heterogenous in their taste for quality, with a fraction  $\lambda$  having taste parameter  $\theta_H$  and the remaining fraction  $1 - \lambda$  having taste parameter  $\theta_L < \theta_H$ . Up to this point, the set up is similar to the simple vertical differentiation model that can be found in Tirole (1988, p. 96-97). The profit-maximizing supplier will always find it in its interest to offer both the low quality and the high quality product to the market.

Now suppose that the consumer is risk averse with utility function  $u(w) = 1 - e^{-\gamma w}$  with  $w$  denoting his wealth level and  $\gamma$  the parameter of risk aversion. The potential loss the consumer faces is equal to the price  $x$  he paid for the product. One can show that for certain parameter values of  $\gamma, \lambda, \theta_L, \theta_H, c_L, c_H, q_L, q_H$  and  $p$ , the insurer maximizes his expected profits when the supplier only supplies the higher quality product, giving him an incentive to eradicate the supply of the low quality product. Moreover, when the consumer “narrow bracket”, that is, treats the purchase and insurance decision as two separate decisions effectively ignoring the risk of loss in his purchase decision, the increase in the insurer's expected profits may exceed the decrease in profits of the supplier compared to the situation where the supplier provides both products. In that case, the insurer can offer full compensation to the supplier: The supplier and insurer

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<sup>7</sup>We use  $x$  to denote price in order to prevent confusion with the loss probability  $p$ .

maximize their joint profits by offering only the high quality product but consumer surplus would be higher in the situation where both products are available.<sup>8</sup> Evidence has been established that people often do narrow bracket (Read *et al.*, 1999; Gottlieb and Mitchell, 2015) and it is conceivable that people have different mental accounts for expenditures on consumption items and insurance.

That said, the narrow bracketing assumption may not hold in all decision contexts. In case consumers incorporate the insurance decision when buying the product, the prospect of paying an insurance premium may reduce their willingness to pay for the product, with a higher reduction for the high quality product since the premium is increasing in loss size. This implies that the insurer may still benefit when only the high quality product is supplied but that joint profits do not increase.

### 2.2.1 The Dutch Market for Electric Bicycles

The Dutch market for bicycles seems fit the description of a market that has recently turned into an insurance market because of the introduction of a new, high quality product: the electric bicycle (E-bike). With annually more than 1 million bicycles sold on a population of approximately 17 million, bicycles in the Netherlands are very much an article of everyday use.<sup>9</sup>

Figure 2 shows that from 2007 to 2014, the sales of bikes with a value of less than €300 has dropped by half, from a market share of over 30% to less than 15%. In the same period, the sales of bicycles in the highest price category (>€900) has almost doubled from a initial market share of 14% to 27%. The main reason for this trend is the increasing popularity of the E-bike: Dutch citizens used to ride traditional bicycles but they have increasingly shifted to E-bikes. The main difference between the two types of bicycles is the addition of a rechargeable battery that offers pedal assistance.<sup>10</sup>

One effect of this development has been that the bicycle market has become attractive for insurers: Whereas consumers did not bother to insure their traditional bicycle, they do insure the more expensive E-bikes. Insurance companies clearly benefit from this development. As one large insurance company says in a press release: *“In the first half of 2015, Univé has sold*

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<sup>8</sup>In Appendix A.3 we show this for the set of parameter values:  $c_L = 0.10$ ;  $c_H = 0.15$ ;  $\theta_L = 0.3$ ;  $\theta_H = 0.6$ ;  $q_L = 0.6$ ;  $q_H = 0.8$ ;  $\lambda = 0.3$ ;  $p = 0.3$  and  $\gamma = 0.9$ .

<sup>9</sup>These and the following numbers on bicycle sales are based on information provided by the RAI Association of vehicle manufacturers and importers, <https://www.raivereniging.nl>

<sup>10</sup>Figure B.1a and Figure B.1b in the Appendix show an example of a traditional and E-bike, respectively.

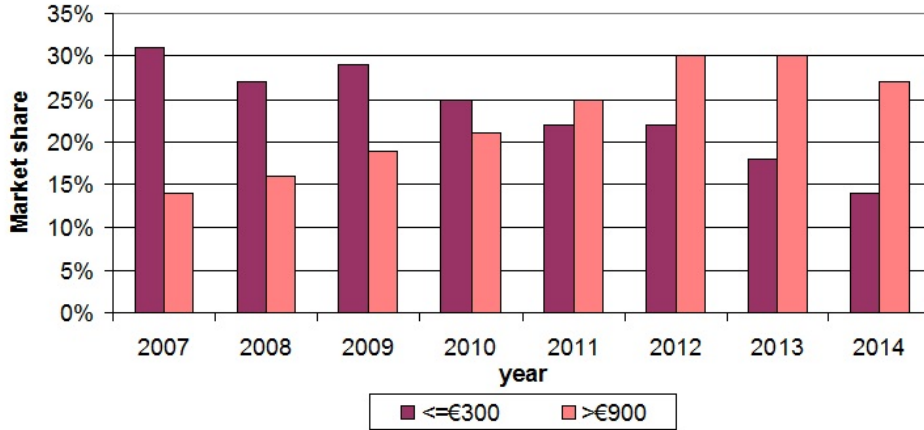


Figure 2: Bike sales Netherlands per price category 2007-2014.

*at least 30 percent more bike insurance policies. A large majority of these insurance policies is specifically for the electric bicycle.*<sup>11</sup>

Now suppose that bicycle producers in this market would enjoy market power. Would this help in lowering prices and increasing consumer welfare to counteract the market power of bicycle suppliers by granting insurers countervailing power? The model in the preceding section suggests that the answer may be no. Instead, insurers may have incentives to phase out the sales of traditional bikes and support the sales of electric bicycles with the costly add-ons. The reason is that every cost reduction also reduces the risk to which the uninsured are exposed, which directly threatens the existence of this novel insurance market.

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.<sup>12</sup>

<sup>11</sup><https://www.unive.nl/actueel/unive-ziet-aantal-fietsverzekeringen-stijgen>, visited 06 October 2015.

<sup>12</sup>For example, the web site 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>

### 3 Experimental Design and Research Hypotheses

Our experiment consists of two stages, a risk elicitation stage (Stage I) and a market stage (Stage II). 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 in all treatments. In the second stage subjects play a market insurance game in groups of 6 (monopoly-treatment) or 7 (duopoly-treatment) subjects. Five subjects are randomly assigned the role of consumer and the other one or two group members assigned the role of insurer. For 30 periods, the insurer chooses a combination of loss size  $L$  and premium  $R$ . By paying the premium  $R$  consumers can insure themselves against the event of a loss of size  $L$ . Consumers may also choose not to buy insurance.

We implement three treatments, one monopoly treatment and two duopoly treatments. All treatments consist of a risk elicitation stage followed by a market stage. 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 greater 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 procedure used by Von Gaudecker, Van Soest and Wengström (2011) who 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  $6 \times 2$  payoff matrix such as shown in Figure 3. 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: when selected, a sure payoff is received. This is a departure from most of the literature, including Von Gaudecker *et al.* (2011), with the exception of Heinemann, Nagel and Ockenfels (2009). We chose this setup to make the decision-making process for subjects as similar as possible to the one they face in Stage II. There 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 rational 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 one of the intermediate rows. The procedure does however not impose monotonicity: subjects are allowed to switch from A to B in a certain row 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  $R = 2, 4, \dots, 18$  and  $R > L$ . In total, subjects thus make 150 (300) decisions in Stage I.<sup>13</sup>

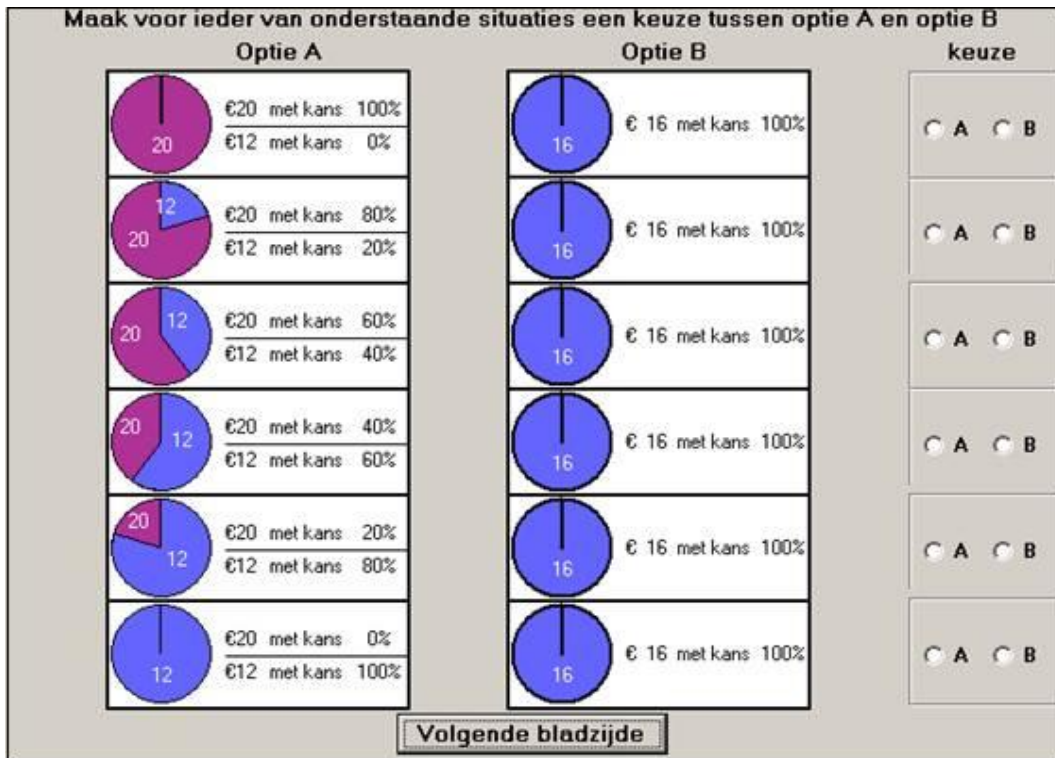


Figure 3: Example of a Stage I multiple price list decision screen.

There is a rich literature on risk and risk perception that measures peoples' risk attitudes in the laboratory. The common finding of these studies is that most people are risk-averse and tend to overestimate the value of avoiding low-probability risks (McClelland et al., 1993). Another experimental finding relevant for the current context is that individuals tend to have a disproportionate preference for certainty (Abdellaoui *et al.*, 2011; Andreoni and Sprenger, 2012). Von Gaudecker, van Soest and Wengström (2011) and others have shown heterogeneity in risk

<sup>13</sup>To compare, in the elicitation design of Von Gaudecker *et al.* (2011) subjects make 28 to 56 decisions including possible sub-screens.



preferences. Therefore, it is better to estimate individual specific risk preference parameters.<sup>14</sup>

All these studies estimate (individual) risk preferences by presenting subjects with different sets of lotteries constructed by the researcher, a procedure we follow in Stage I. The bets buyers face in Stage II are instead constructed by the subject(s) with the role of insurer. This raises two questions. First, to which extent are insurer-subjects able to learn the risk attitudes of their population of potential buyers and to offer loss size/premium combinations that maximize their expected profits? Second, are choices made by consumer-subjects in the two stages consistent, such that the revealed risk preferences in Stage I can predict a consumer-subject's Stage II choices? The answer to the second question is also important in illuminating the issue whether risk attitudes elicited by individual-decision tasks in the lab carry over to interactive market contexts. We are not aware of any other experimental studies that have investigated these issues.

### 3.2 Stage II: The market insurance game

The second part last for 30 periods. Subjects are randomly matched into separate markets of six or seven subjects. 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  $W = \text{€}20$ . In each period, the insurer-subjects in the group have the task to set a premium  $R_i$  and a loss size  $L_i$ , both in the range  $[0, W]$  ( $i = 1, 2$ ). By paying the premium to the insurer, consumers are protected against the event of a loss. Losses occur with an exogenously given probability  $p = 0.60$ .

Ex ante, we envisioned that insurer-subjects might have difficulties in simultaneously choosing two strategic variables, so we also ran a number of sessions with an exogenously given loss size (these are the sessions no. 1-3 and 8-10 in Table B.1). In this way, we could see whether for given loss sizes insurer-subjects were able to find the profit maximizing premium in their market. It turned out that they were able to do so. For that reason, in what follows we focus on the sessions with endogenous loss sizes.<sup>15</sup>

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<sup>14</sup>Risk preferences have also been estimated in the field (Beetsma and Schotman, 2001; Harrison *et al.*, 2007; Dohmen *et al.*, 2010) or using field data by inferring risk preferences from deductible choices (Cohen and Einav, 2007; Ericson *et al.*, 2015). Using data on people's deductible choices, Sydnor (2010) and Barseghyan *et al.* (2013) find that people overinsure in real life insurance markets.

<sup>15</sup>We also ran a number of sessions with a smaller loss probability of  $p = 0.20$  (Sessions 4, 7 and 12 in Table B.1). Results of the sessions with exogenous loss sizes and  $p = 0.2$  are available upon request.

### 3.3 Monopoly treatment

The monopoly treatment MONOP-NI is designed as a non-insurance market with initial loss size  $L_0 = 0$ . Uninsured consumers face a potential loss of  $L$ , with  $L$  determined as

$$L = \max(L_1, L_0). \quad (1)$$

This resembles a non-insurance market because without the presence of the insurer, consumers would face a potential loss equal to  $L = L_0 = 0$ . In such a market, the presence of an insurer can only increase the potential loss of the uninsured. The loss size set by the monopolist is to be interpreted as the non-exclusive negotiated price with a service supplier in case one of the insurees experiences a loss. After having learnt the premium(s) and the potential loss  $L$ , consumers decide whether or not to insure. Note that this experimental setting is akin to the extreme case where the insurer has full bargaining power vis-à-vis the supplier. In practice, this may happen when the insurance company is vertically integrated with the upstream market.

### 3.4 Duopoly treatments

In the two duopoly treatments of the experiment, this potential loss for the uninsured is determined as

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

with  $L_0$  the initial loss size and  $L_i$  the loss size set by insurer  $i$ . Notice that with  $L_2$  set to 0, this reduces to equation (1). We implement two choices of  $L_0$ : a non-insurance market (DUOP-NI) for which  $L_0 = 0$  and a insurance market (DUOP-I) for which  $L_0 = 20$ .

Figure 4 shows an example of a decision screen consumers may face in Stage II of DUOP-NI: 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 from insurer 2 at a premium of 12.0. Most likely, insurer 2 has set a much larger loss size. It is conceivable that in this period, insurer 2 will not attract any customers. This illustrates the strong incentive embodied in (2) for competing insurers to undercut the rival's loss size, giving the competitive outcome of Proposition 2 its best shot. Table 1 gives a summary of different Stage II treatments.

**Payoffs** In each period, an 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

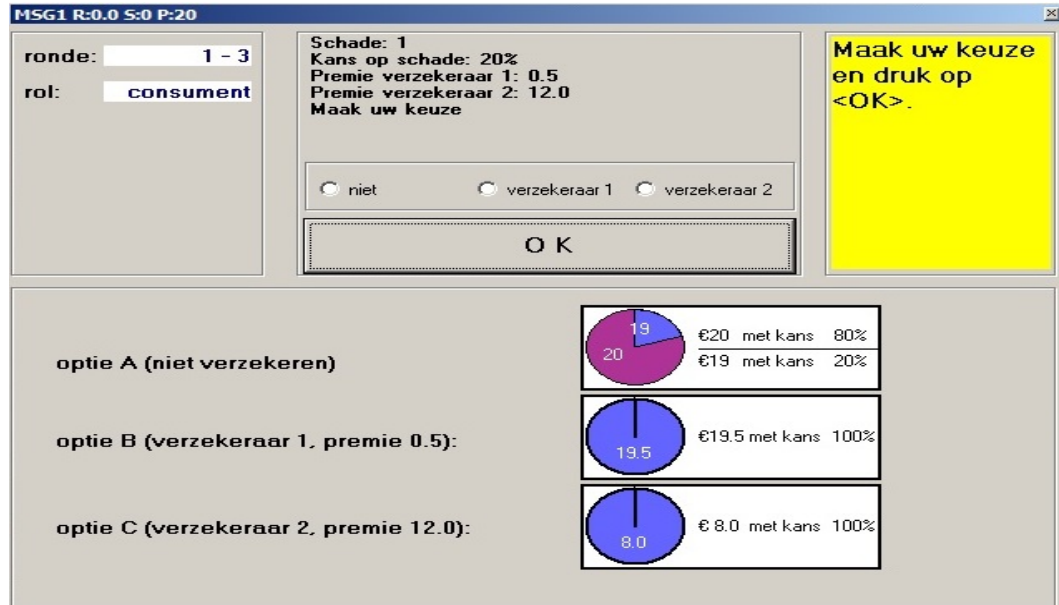


Figure 4: Example of a Stage II consumer decision screen in the DUOP-NI treatment.

Table 1: Summary of Stage II treatments: The market insurance game

Treatment	# cons.	# insurers	Decision variables	Pot. loss uninsured	Loss prob. ( $p$ )	# sessions
MONOP-NI	5	1	$R, L$	$\max(L, 0)$	0.6	3
DUOP-NI	5	2	$R_1, R_2, L_1, L_2$	$\max(\min\{L_1, L_2\}, 0)$	0.6	2
DUOP-I	5	2	$R_1, R_2, L_1, L_2$	$\max(\min\{L_1, L_2\}, 20)$	0.6	2

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.

For insurer-subjects we decided on a different payment structure because payment based on a single period may result in losses even for insurers who systematically set their premium higher than the expected loss in case the randomly chosen period turns out to a period in which a high number of their customers happens to experience a loss. To avoid this, insurer-subjects were paid 10% of their accumulated profits. This payoff structure may also help to induce insurer subjects to behave as risk-neutral agents because the impact of an individual random draw on their final earnings becomes small.

### 3.5 Research hypotheses

We derive the theoretical equilibrium predictions for the experimental monopoly and duopoly markets under the assumption that consumer-subjects are risk-averse and insurer-subjects are risk-neutral.

**Monop-NI** ( $L_0 = 0$ ) The monopolistic insurer has an incentive to set  $L_1$  higher than zero in order to create a market for his product. Proposition 1 predicts that the insurer 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. This prediction corresponds in Figure 1 to contingent claim  $\mathbf{M_L}$  for the insured and  $\mathbf{A}$  for the uninsured.

**Duop-NI** ( $L_0 = 0$ ) In the non-insurance duopoly market, competition will push back loss sizes to the point  $L_1 = L_2 = \underline{L}(c)$ , the potential loss for which a consumer is indifferent between buying insurance at the actuarially fair rate or remaining uninsured. Competition will also force insurers to charge actuarially fair premiums  $R_1 = R_2 = p \times \underline{L}(c)$ . We do not observe the cost of effort  $c$  experimental subjects experience in buying insurance but for  $c > 0$ , we expect to see equilibrium premiums and loss sizes strictly above zero. This prediction corresponds to contingent claim  $\mathbf{C_S}$  in Figure 1.

**Monop-I and Duop-I** ( $L_0 = 20$ ) Negotiated discounts are not available to uninsured consumers who continue to face a potential loss of  $L_0 = 20$ . The presence of one or more insurance companies can therefore only benefit consumers by offering protection against a large potential loss. The monopolistic insurer does not have to worry that lowering  $L_1$  will reduce the demand for his product because of the exclusivity of any negotiated discount. 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. This prediction corresponds in Figure 1 to contingent claim  $\mathbf{M_L}$  for the insured. The uninsured face contingent claim  $\mathbf{A}$  but other than in MONOP-NI this is independent of the potential loss size selected by the insurer. For this reason, we do not implement treatment MONOP-I because the only predicted difference with MONOP-NI is higher profits for the insurer-subjects.

For the duopoly market, the fact that uninsured consumers continue to face a potential loss of  $L_0 = 20$  ensures that the insurance market will not erode. The exclusivity of negotiated discounts thereby lifts the constraint that prevents insurer-competition in DUOP-NI to push loss sizes to 0. The unique equilibrium for this case is when  $R_1 = R_2 = L_1 = L_2 = 0$ . This prediction corresponds to contingent claim **D** in Figure 1.

The theoretical predictions regarding the choices made by the insurer-subjects in the experiment are summarized in Table 2. These predictions are the research hypotheses of our experimental investigation. The table shows that compared to the initial claim size  $L_0$ , consumers in non-insurance markets are worse off when one or more insurance companies with buyer power enter, unless the transaction cost of taking out insurance is 0. In the latter case, they are equally well off in the duopoly, but not in the monopoly case. Consumers in insurance markets are equally well off when a monopolistic insurer with buyer power enters and strictly better off when two competing insurers with buyer power enter. In sum, granting insurers countervailing buyer power only seems a good idea when the market actually is an insurance market and the insurers face sufficient competition from other insurers.

Table 2: Research hypotheses on the predicted outcomes in the experimental markets (risk-averse consumers, loss probability  $p = 0.6$ ).

	Cont. claim	Loss size uninsured	Expected profit	Premium	Consumer preference
NON-INSURANCE MARKET ( $L_0 = 0$ )					
MONOP-NI	<b>M<sub>L</sub></b>	20	$\pi_{M_L} > 0$	$> 12$	$I \sim NI$
DUOP-NI	<b>C<sub>S</sub></b>	$\underline{L}(c)$	0	$0.6 \times \underline{L}(c)$	$I \sim NI$
INSURANCE MARKET ( $L_0 = 20$ )					
MONOP-I	<b>M<sub>L</sub></b>	20	$> 12$	$> 12$	$I \sim NI$
DUOP-I	<b>D</b>	20	0	0	$I \succ NI$

## 4 Experimental Procedure and Data

The experiment was conducted at the CREED experimental laboratory of the University of Amsterdam in June and November 2012 and October 2013. Sessions lasted between 1h25m and 1h50m. We ran a total of 20 sessions in which a total of 377 subjects participated in 60 separate markets. Of these subjects, 245 participated in one of four treatments described in the previous section: 60 (66) in the monopoly market with exogenous (endogenous) loss size and 56 (63) 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. Table B.1 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 the experiment to euro's paid.

Table 3 summarizes per treatment the most important background characteristics plus some of the outcomes, splitting the sample based on the subject's role in the market stage. The average age of 21/22 years reflects the fact that our sample consists of students of the University of Amsterdam. In all treatments, about half of the subjects is female. For age and gender, no significant differences between treatments are found. When we consider final earnings, we observe that subjects on average earn €27.28 which is well-paid for an experiment that lasts about 1h35m.<sup>16</sup> The risk elicitation stage is the same for all treatments so earnings are also very similar. There is however large between-treatment variation in the market stage earnings. Insurer-subjects earn on average €13.74 in the market stage of the monopoly treatment but are not able to attain positive earnings in the competitive non-insurance market DUOP-NI. However, in the competitive insurance market DUOP-I, insurers earn on average €21.83, which is significantly more than in the monopolistic non-insurance market. As we will see, the reason for this is that insurer-subjects in these markets manage to set the losses that they have to payout to their clients at very low levels while only partly passing these benefits to their clients in the form of low premiums.

For consumer-subjects, the actual earnings have not been recorded for the two stages separately, but because we can assume that earnings in the risk elicitation stage are very similar across treatments, differences in total earnings are likely to reflect differences in earnings in the market stage. We observe that in both DUOP-NI and DUOP-I, consumer-subjects leave the lab with more money than in MONOP-NI with no significant differences between the two duopoly treatments. In the next section, we will study in greater detail the underlying behaviors that

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<sup>16</sup>€1 = \$1.33, exchange rate of January 1st 2013.

Table 3: Summary statistics subjects (standard deviations in parentheses) ( $p = 0.6$ ).

		MONOP-NI $L_0 = 0$		DUOP-NI $L_0 = 0$		DUOP-I $L_0 = 20$	
Role:	Insurers	Consumers	Insurers	Consumers	Insurers	Consumers	
	(1)	(2)	(3)	(4)	(5)	(6)	
Fraction females	0.182 (0.405)	0.472 (0.504)	0.467 (0.516)	0.486 (0.507)	0.500 (0.519)	0.459 (0.505)	
Age	21.73 (1.79)	22.30 (3.28)	22.00 (3.82)	21.16 (2.69)	21.53 (2.88)	21.22 (2.50)	
<b>Risk elicitation stage</b>							
$\hat{\gamma}_i$	median	0.029	0.081	0.089	0.083	0.082	0.095
	mean	0.029 (0.061)	0.091 (0.079)	0.2003* (0.309)	0.110 (0.111)	0.072 (0.054)	0.101 (0.086)
$\hat{\tau}_{s(i)}$	median		1.274		1.136		1.202
	mean		1.284 (0.068)		1.169 (0.087)		1.231 (0.148)
<b>Final earnings (in €)</b>							
	Total earnings <sup>1</sup>	29.74 (10.69)	25.70 (7.89)	12.87*** (7.00)	29.02** (6.09)	36.50††† (18.87)	28.52* (8.13)
	Risk elicitation stage	16.00 (4.20)	- (-)	14.12 (6.30)	- (-)	14.67 (6.17)	- (-)
	Market stage	13.74 (8.21)	- (-)	-1.26*** (4.43)	- (-)	21.83††† (17.25)	- (-)
	obs.	11	55	16	40	18	45

**Notes:** <sup>1</sup> For consumer-subjects, it was not separately recorded which of the stage I and II decisions were paid out (subjects were only informed about their earnings after the experiment had ended).

\*\*\*(\*\*, \*) indicate statistically significant differences with MONOP-NI at the 1%-level (5%-level, 10%-level);

†††(††, †) indicate statistically significant differences with DUOP-NI at the 1%-level (5%-level, 10%-level). Significance based on two-sided pairwise nonparametric Mann-Whitney rank-sum tests.

have caused these outcomes.

## 5 Experimental results

We split the discussion of our results in three parts. First, in Section 5.1 we analyze the results of the risk elicitation stage. The high number of subject-decisions in this stage allows us to estimate risk attitudes at the individual level. We evaluate the consistency of subjects' stage I choices and compare our risk preference estimates with those found elsewhere in the literature. As an extra check on the success of our randomization, we also compare the distribution of risk preferences across treatments, distinguishing between subjects assigned the role of consumer

in the market stage and those assigned the role of insurer. Section 5.2 returns to the main topic of this paper by presenting the outcomes of the market insurance game. We relate the results regarding the premiums and loss sizes observed, the consumers' insurance choices and the insurers' profits to the research hypotheses as summarized in Table 2.

Of particular interest for our purposes is to analyze between-stage decision-consistency by subjects assigned the role of consumer in the market stage. To which extent do the decisions in the risk elicitation stage correctly predict the decisions these subjects make in the market stage? The type of decisions they face in both stages is very much comparable, but whereas they are in an individual decision-making game in Stage I with the options offered by a computer, they are in a strategic market context in Stage II when the options are offered by another subject in their market. Any observed difference in behavior would be indicative that subjects have a different attitude towards choosing between risky prospects and insurance choices. Section 6 presents an elaborate analysis of these issues.

## 5.1 Individual risk preferences

First, we use the decisions from the risk elicitation stage to estimate the individual-specific risk parameter for the subjects with the role of consumer in the market stage of the experiment. To this end, we apply a structural econometric model related to the one introduced by Von Gaudecker *et al.* (2011) and estimate this model by maximum likelihood.<sup>17</sup> For ease of comparison, we borrow their notation. We assume that subjects' risk preferences can be represented by an expected utility framework with the standard CARA exponential utility function

$$u(z, \gamma) = -\frac{1}{\gamma}e^{-\gamma z}. \quad (3)$$

with  $z \in \mathbb{R}$  denoting a lottery and  $\gamma \in \mathbb{R}$  the Arrow-Pratt coefficient of absolute risk aversion.

In the risk elicitation stage, subjects  $i \in \{1, \dots, N\}$  repeatedly choose between two lotteries  $\pi_j^A$  and  $\pi_j^B$  ( $j \in \{1, \dots, J_i\}$ ). Lottery  $A$  is a binary lottery with a high outcome  $A^{high}$  that happens with probability  $p^{high}$  and a low outcome  $A^{low}$  that happens with probability  $1 - p^{high}$ ; lottery  $B$  is a degenerated lottery:

$$\pi_j^A = (A_j^{low}, A_j^{high}, p_j^{high}); \quad \pi_j^B = B^{cert} \quad (4)$$

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<sup>17</sup>Motivated by their research objectives, the model in Von Gaudecker *et al.* (2011) also incorporates loss aversion and time preferences for uncertainty resolution in the utility specification. In our study, none of the lotteries  $A$  and  $B$  involves a loss and subjects receive immediate feedback on whether or not a loss has occurred and in all cases get paid out immediately after the end of the experiment.



Let the outcome variable  $Y_{ij}$  be such that:

$$Y_{ij} = \begin{cases} 1 & \text{if the individual chooses } B \\ 0 & \text{otherwise.} \end{cases} \quad (5)$$

The corresponding certainty equivalents are:

$$CE(\pi_j^A, \gamma_i) = -\ln\{-\gamma_i u(\pi_j^A)\}/\gamma_i \text{ and } CE(\pi_j^B, \gamma_i) = B_j^{cert}. \quad (6)$$

with

$$\begin{aligned} u(\pi_j^A) &= p_j^{high} u(A_j^{high}) + (1 - p_j^{high}) u(A_j^{low}) \\ &= - \left( \frac{p_j^{high} e^{-\gamma_i A_j^{high}}}{\gamma_i} + \frac{(1 - p_j^{high}) e^{-\gamma_i A_j^{low}}}{\gamma_i} \right) \\ &= -\frac{1}{\gamma_i} \left[ p_j^{high} e^{-\gamma_i A_j^{high}} + (1 - p_j^{high}) e^{-\gamma_i A_j^{low}} \right]. \end{aligned} \quad (7)$$

Combining equations (6) and (7), the difference in the certainty equivalents of lottery  $A$  and  $B$  can be written as:

$$\begin{aligned} \Delta CE_{ij} &= CE(\pi_j^B, \gamma_i) - CE(\pi_j^A, \gamma_i) \\ &= B_j^{cert} + \frac{1}{\gamma_i} \ln\{p_j^{high} e^{-\gamma_i A_j^{high}} + (1 - p_j^{high}) e^{-\gamma_i A_j^{low}}\} \end{aligned} \quad (8)$$

We follow Von Gaudecker *et al.* (2011) in our further econometric implementation. Whereas a perfectly rational decision-maker selects  $\pi_j^B$  if and only if  $\Delta CE_{ij} > 0$ , we allow for uncertainty by adding Fechner errors  $\epsilon_{ij}$  to the deterministic economic model (see e.g. Graham Loomes, 2005). The decision problem of the individual now reads:

$$Y_{ij} = \mathbb{I}(\Delta CE_{ij} + \tau \epsilon_{ij} > 0) \text{ with } \tau \in \mathbb{R}_+ \quad (9)$$

with  $\mathbb{I}$  denoting an indicator function. If  $Y_{ij} = 1$ , individual  $i$  chooses to buy insurance when faced with choice situation  $j$ . The behavioral interpretation of this specification is that individuals may be prone to some degree of inattention when evaluating the options, with the likelihood of choosing the less-preferred option increasing as  $\Delta CE$  becomes small. The individual's probability to make this type of 'mistakes' increases with the parameter  $\tau \in \mathbf{R}_+$ . As pointed out by Von Gaudecker *et al.* (2011), using certainty equivalents instead of utility differences facilitates comparisons across subjects. Other than Von Gaudecker *et al.* (2011), our main interest is in using the estimation procedure to back out the risk-preferences of individual subjects in the

different experimental estimates. To this end, we estimate the individual-specific risk-preference parameter  $\gamma_i$ , whereas Von Gaudecker *et al.* (2011) try to retrieve the distribution of this parameter in the population. This higher flexibility in estimating individual risk-preferences implies that we have to be more parsimonious in other dimensions. For this reason, and because this is outside the scope of the current paper, we do not allow for “trembling hand” type of errors individuals to choose randomly with a given fixed probability (Harless and Camerer, 1994).<sup>18</sup>

The probability of the observed choice  $Y_{ij}$  of individual  $i$  in choice situation  $j$ , given all the individual specific parameters, is given by:

$$l_{ij}(\pi_j^A, \pi_j^B, Y_{ij}, \tau_s(i), \gamma_i) = \Lambda \left( (2Y_{ij} - 1) \frac{1}{\tau} \Delta C E_{ij}(\pi_j^A, \pi_j^B, \gamma_i) \right). \quad (10)$$

where  $s(i)$  denotes the session in which subject  $i$  participates and  $\Lambda(t) = (1 + e^{-t})^{-1}$  the cumulative standard logistic distribution function. We estimate the parameters by maximum likelihood. The log likelihood function maximized is the sum of the log likelihood contributions of each subject.

Figure 5 shows the histogram of the estimated individual risk preference parameters of the subjects in our sample. It is reassuring that with a median value of 0.082 and a mean value of 0.1033, the resulting distribution is very similar the population distribution estimated by Von Gaudecker *et al.* (2011, Figure 4a).<sup>19</sup> Reassuringly for the success of our randomization, Table 3 shows that for consumers, the estimated risk-preference parameters are very similar across treatments; for subjects acting as insurer, we find that those in DUOP-NI are slightly more risk averse ( $p = 0.068$ ) than those in MONOP-NI. For DUOP-NI, a regression however does not indicate a relation between insurer risk attitudes and the minimum premium available to consumers in the market stage.<sup>20</sup>

Figure 6 shows for subjects in MONOP-NI and DUOP-NI with different risk preference estimates (one risk loving, one ‘risk neutral’ and one risk averse) the risk-elicitation stage choices that involved a loss probability of  $p = 0.6$ . In the map, the solid line indicates the choice-situations

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<sup>18</sup>As Von Gaudecker *et al.* (2011), we estimate  $\tau$  together with the preference parameters but whereas all individuals have the same  $\tau$  in their specification, we can allow for session-specific  $\tau$ 's ( $\tau_s$ , with  $s \in \{1, \dots, S\}$  and  $S$  the total number of sessions) because we do not include a ‘trembling hand’ parameter. As they notice, it proves difficult in practice to estimate heterogeneity in  $\tau$  and the ‘trembling hand’ parameter separately.

<sup>19</sup>Von Gaudecker *et al.* (2011) impose more structure and for this reason their distribution is smoother than ours.

<sup>20</sup>We regressed the average minimum market premium on the insurer’s estimated  $\gamma$ 's while clustering at the market level.

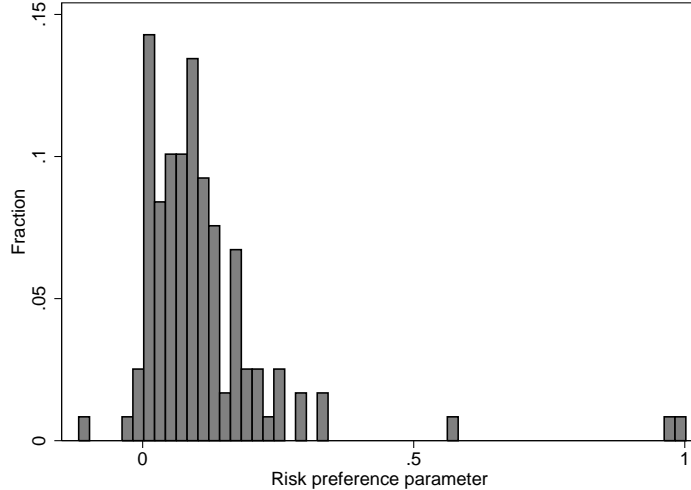


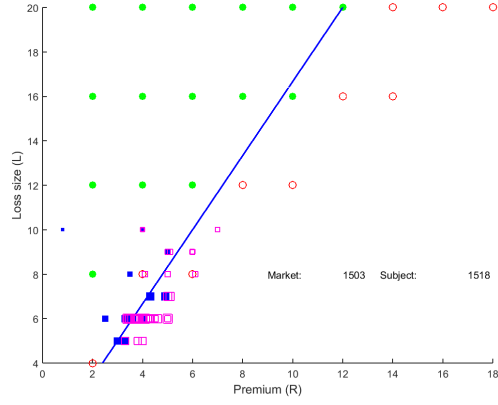
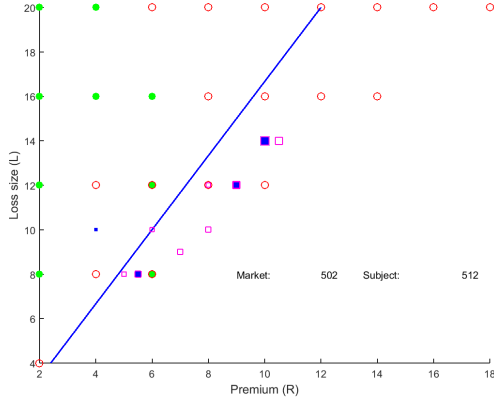
Figure 5: Distribution of estimated risk aversion parameters  $\gamma$ .

that make a risk-neutral agent 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 dots are filled (hollow) when the subject actually decided (not) to insure in the risk-elicitation stage when faced this situation by choosing Option  $B$  ( $A$ ). Since each of the 25 screens only contained one such decision, each dot in Figure 6 relates to a different screen (ignore the squares for the moment, these relate to Stage II decisions).<sup>21</sup> In this light, it is remarkable how consistent subject choices in this stage are: the areas of filled and hollow dots are almost completely separated. A vertical comparison of the panels reveals that the differences in  $\hat{\gamma}$ 's indeed reflect the differences in individual risk-preferences in choices that involve  $p = 0.6$ , this despite the fact that the  $\gamma$ 's are estimated also including the choices that involve loss probabilities  $p \neq 0.6$ .

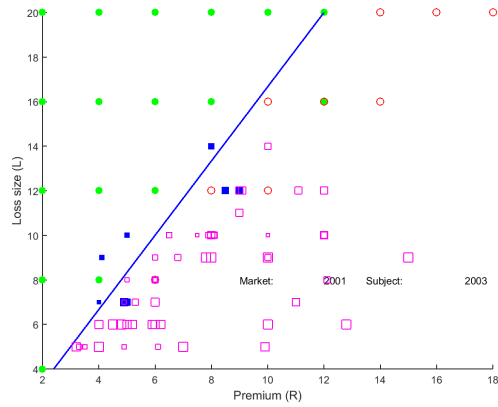
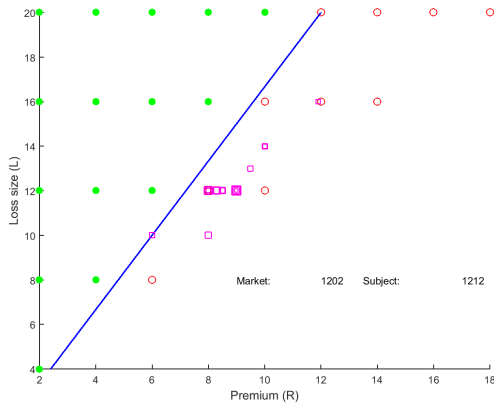
## 5.2 The Market Insurance Game

In this section, we will present the treatment effects on the key outcome variables of the market stage of our experiment: premiums, loss sizes, expected consumer earnings and insurer profits. However, our design with non-automated live-buyers necessitates that we first consider which  $(R, L)$ -combinations are most profitable in our experimental markets and ascertain whether these combinations are roughly the same across treatments. To this end, we construct per treatment for each  $(R, L)$ -combination with  $p = 0.6$  the aggregate demand for insurance by considering the Stage I decisions of the subjects who are assigned the role of consumer in the

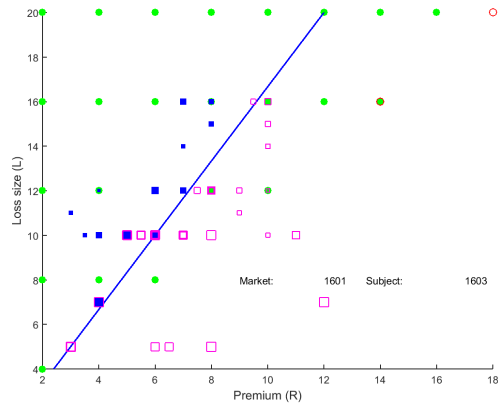
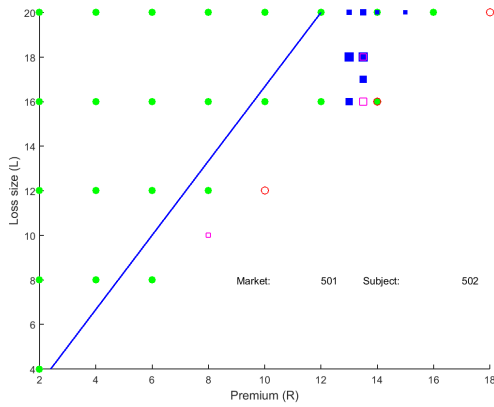
<sup>21</sup>For example, the combination  $(R, L) = (2, 12)$  appeared in screen #3, the combination  $(R, L) = (6, 12)$  in screen #21.



(a) MONOP-NI: Subject #512 ( $\hat{\gamma} = -0.040$ ). (b) DUOP-NI: Subject #1518 ( $\hat{\gamma} = -0.006$ ).



(c) MONOP-NI: Subject #1212 ( $\hat{\gamma} = 0.002$ ). (d) DUOP-NI: Subject #2003 ( $\hat{\gamma} = 0.009$ ).



(e) MONOP-NI: Subject #502 ( $\hat{\gamma} = 0.108$ ). (f) DUOP-NI: Subject #1603 ( $\hat{\gamma} = 0.101$ ).

Figure 6: Choices by selected subjects in treatments MONOP-NI (left panels) and MONOP-NI (right panels). Loss probability  $p = 0.6$ .

**Notes:** The solid line is the risk neutral line: a risk-neutral agent should choose (not) to insure for choice-combinations to the left (right) of this line. The dots show the subject's actual decisions in the risk-elicitation game (Stage I): they are filled and green when Option B ('insure') has been chosen and hollow and red if Option A ('not insure') has been chosen. The squares shows the offers made by the insurers in the market stage (Stage II): these are filled and blue if the consumer-subject took the offer. The size of the squares is increasing with the period in which the offer was made. Estimates of  $\gamma$  based on all Stage I choices.

market stage. This procedure provides us with a map for the aggregate demand for insurance at the treatment level.<sup>22</sup> These maps are shown in Figure 7. The squares in the grid indicate the actual decisions of subjects in the risk elicitation stage. The numbers next to the squares indicate how many chose to take insurance (the more subjects take insurance the greener the square is). The maps also show the iso-expected-profit curves of a monopolistic insurer who would serve such a (hypothetical) market. For example, in MONOP-NI, 49 subjects (out of the 55) decided to buy insurance (i.e. they chose Option B) when options A and B corresponded to  $(R, L) = (4, 8)$ .<sup>23</sup>

There are a number of important points to take away from these maps. First, in line with the individual estimates of risk preferences, in all treatments a majority of consumer-subjects shows risk-averse behavior. For example, in all treatments, most subjects decide to buy insurance at a premium 8 to be safeguarded against a 60% probability to lose 12. Second, the iso-profit curves are very similar across treatments, reinforcing our earlier observation that any difference in outcomes cannot be explained by treatment heterogeneity in consumer risk preferences. Third, in each of these markets, a profit-maximizing monopolistic insurer would do best if he sets the loss size close at 20 and offers insurance at a premium of about 14 to 16.<sup>24</sup>

In sum, if the decisions of consumer-subjects in the market stage of this experiment are consistent with their first stage elicited risk-preferences (which is investigated in Section 6.1), monopolistic insurer-subjects indeed maximize expected profits by setting the loss size  $L$  at the maximal value, in line with the theoretical argument posed in Proposition 1. We next turn to the question whether insurer-subjects in MONOP-NI are able to uncover the particular iso-profit map of their market and set the loss size and premium to the profit-maximizing level.

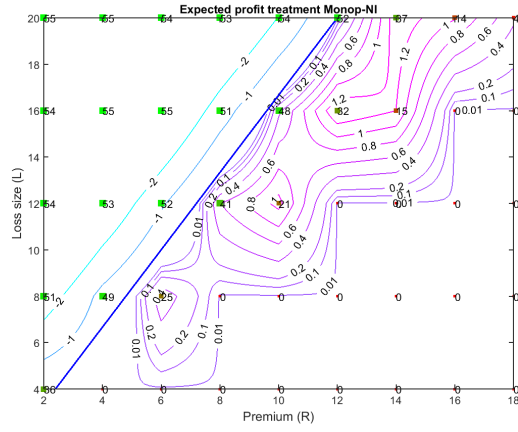
### 5.2.1 The Monopolistic Non-Insurance Market

In Table 2 we hypothesize that monopolistic insurers in the non-insurance markets MONOP-NI will design a contingent claim  $\mathbf{M}_L$  such that the premium exceeds 12, the uninsured face a loss size of 20 and expected profits  $\pi_{M_L}$  are strictly positive. The results in Table 4 provide some

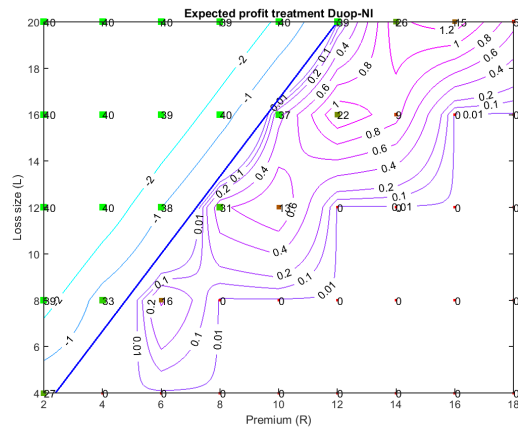
<sup>22</sup>The *per-market* aggregate demand functions may look slightly different because each market only contains a sub-sample of five consumer-subjects. In the online Appendix we provide plots for each separate market.

<sup>23</sup>This particular combination corresponds to the fourth choice situation in Figure 3.

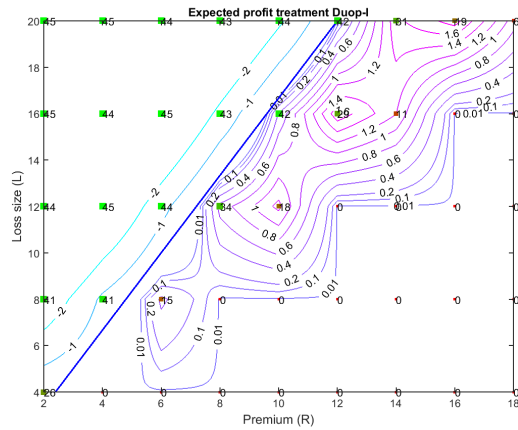
<sup>24</sup>We provide a numerical example for MONOP-NI: at a premium of 14 and a loss size of 20, 37 subjects out of the 55 consumer-subjects would take insurance and the insurer's per consumer expected profits would equal  $(37/55) \times (14 - 0.6 \times 20) = 1.35$ ; setting a loss size of 16 and a premium of 10 would lead to expected per consumer profit of  $(48/55) \times (12 - 0.6 \times 16) = 0.35$ .



(a) MONOP-NI



(b) DUOP-NI



(c) DUOP-I

Figure 7: Stage I aggregate decisions by consumer-subjects (squares) for choice combinations involving a loss probability  $p = 0.6$  and the corresponding iso-expected-profit curves for a monopolistic insurer.

**Notes:** The number to the right of each  $(L, R)$ -combination denotes the total number of consumer subjects in the treatment that chose Option B ('insure') in the risk-elicitation stage. Based on these choices, we calculate the profits an insurer earns in expectation when offering  $(L, R)$  in all 30 periods. Iso-profit lines are shown for the levels  $[-200, -100, 1, 20, 40, 60, 80]$ . The plots were created in Matlab using the `interp2` function for interpolation of the 27 gridded data. The solid line is the risk neutral line.

Table 4: Main experimental outcomes (market level standard deviations in parentheses).

Periods	1-15			16-30		
	MONOP-NI	DUOP-NI	DUOP-I	MONOP-NI	DUOP-NI	DUOP-I
Min. Premium ( $R$ )	10.68 (1.89)	5.29*** (1.41)	4.53*** (1.43)	11.59 (2.17)	4.99*** (1.15)	3.54***,† (1.68)
Loss Size ( $L$ )	15.16 (1.41)	9.02*** (2.5)	20.00***,††† (0.00)	16.44 (2.96)	7.71*** (2.07)	20.00***,††† (0.00)
Fraction Insured	0.44 (0.10)	0.59 (0.23)	0.96***,††† (0.04)	0.53 (0.16)	0.44 (0.19)	0.96***,††† (0.04)
Expected Profits Insurers	2.87 (2.50)	-1.25*** (1.47)	6.93***,††† (2.92)	4.59 (3.18)	-0.12*** (0.69)	7.27††† (4.24)
Expected Earnings Consumers	10.33 (1.83)	14.94*** (1.43)	15.18*** (1.47)	9.22 (2.12)	15.36*** (1.15)	16.21*** (1.82)
obs.	11	16	18	11	16	18

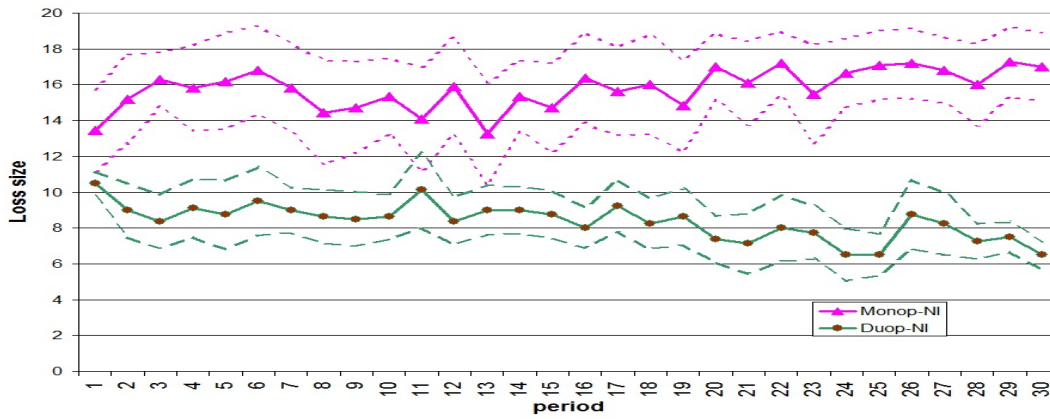
**Notes:** \*\*\*(\*\*, \*) indicate statistically significant differences with MONOP-NI at the 1%-level (5%-level, 10%-level); †††(††, †) indicate statistically significant differences with DUOP-NI at the 1%-level (5%-level, 10%-level). Significance based on two-sided pairwise nonparametric Mann-Whitney rank-sum tests.

support. When we focus on the final 15 periods, both the uninsured loss size and the premium are far above zero, although the loss size for the uninsured is strictly below the upper bound of 20 ( $p < 0.001^{25}$ ) and, correspondingly, the average premium is with 11.59 not significantly different from 12 ( $p = 0.545$ , two-sided  $t$ -test) but sufficiently high to generate profits that are strictly positive in expectation ( $p < 0.001$ ). Consumers on average take out insurance in 52.7% of the cases, a number that is not significantly different from 50% ( $p = 0.205$ , two-sided  $t$ -test).

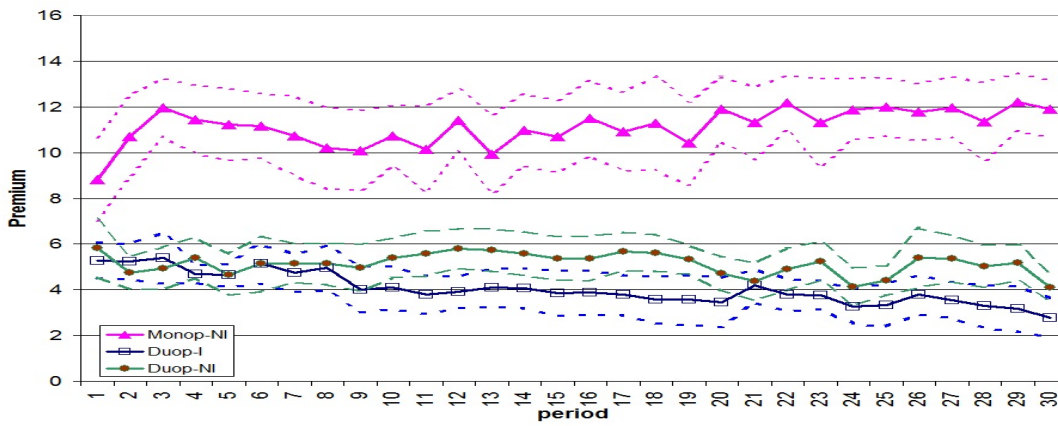
Insurers' average expected profits are 4.59 and clearly positive whereas consumers expected earnings are on average 9.22. This is still somewhat better ( $p < 0.001$ ) than the expected earnings of 8 ( $= (1 - 0.6) \times 20$ ) consumers can expect to earn in case no insurance would be offered to protect against a potential loss of 20 that materializes with probability  $p = 0.6$  but the point of course is that the potential loss does not come down.

Figure 8 shows for all treatments the average market loss sizes and premiums over time and the average percentage of consumers that buys insurance in a given period. Panels (a) and (b) show that in MONOP-NI, average potential loss sizes and premiums settle fairly quickly around the values of 16 and 12, respectively. The average percentage of consumers buying insurance (panel (c)) continues to show considerable variation, which is indicative of insurer-subjects efforts to tweak the loss size/premium-combination such that they extract the maximal surplus from

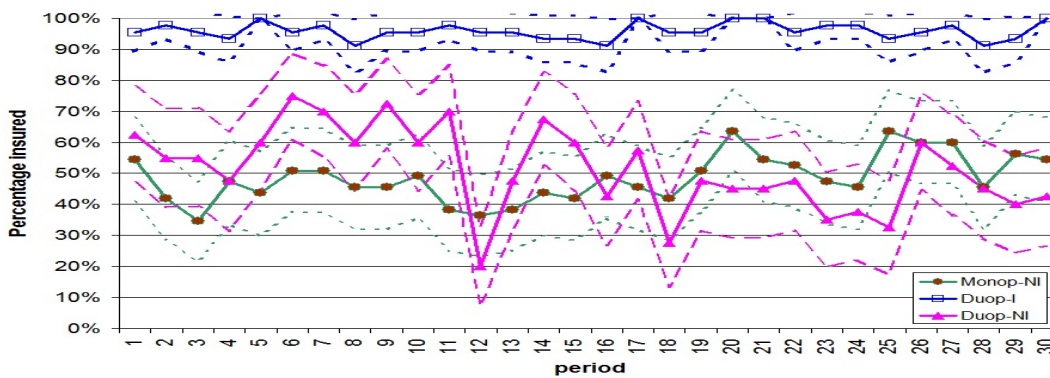
<sup>25</sup> $p$ -values in this section are based on one-sided  $t$ -tests, unless stated otherwise.



(a) The average potential loss size uninsured consumers face.



(b) Average premium set by insurers.



(c) Average percentage of all consumers that decides to buy insurance.

Figure 8: Per period average market stage outcomes for MONOP-NI (triangles) and DUOP-NI (circles) and DUOP-I (squares).

**Notes:** The dashed lines depict the mean  $\pm$  two standard error confidence intervals. The loss size for the uninsured is always 20 in DUOP-I and therefore not shown in panel (a).



the consumers in their market.

Figure 9 shows for each treatments the average per period profits and earnings insurers respectively consumers can *expect* given their choices and the objective loss probability  $p = 0.6$ . Note that in considering ex ante expected outcomes instead of ex post realizations, the plots ignore the noise caused by the idiosyncratic draws of nature that influence the actual outcomes subjects experience. Panel 9a clearly shows that as the experiment progresses, insurer-subjects in MONOP-NI learn how to attain higher profits. Panel 9b shows that as a result, consumer earnings decrease over time.

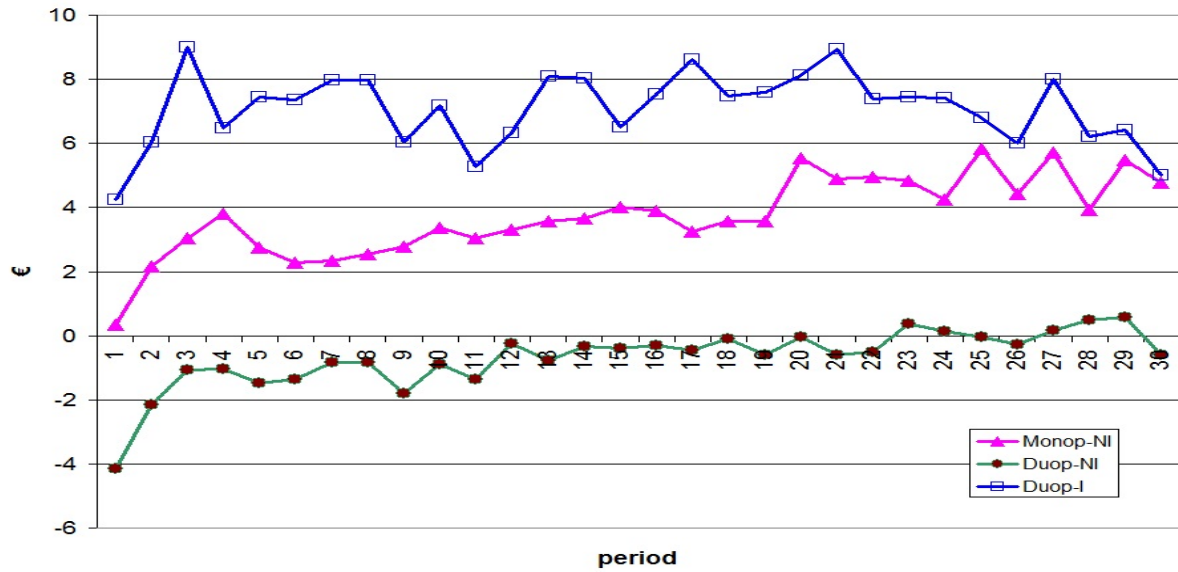
For the example subjects in Figure 6, the squares denote the premium-loss size combinations that were actually offered to them the insurer(s) in their market. Squares are solid (hollow) if the subject decided (not) to accept the offer. Larger squares correspond to later periods in the market stage. For the markets shown, the  $(L, R)$ -choices of the insurer in market #502 (panel e) clearly converge to the theoretical prediction of  $(20, 14)$ . This is less true for the choices of the insurers in markets #512 and #1212. The iso-profit curves for those markets (see the online Appendix) show that this is because the consumer risk-preferences in those markets generate a rather flat profit function in  $(L, R)$ -space without a clear maximum. In general, insurer-subjects seem well able to find the profit maximizing combination of their two choice variables given the risk-preferences of the consumers in their market. This is a remarkable achievement, especially since they do not know the consumer-subjects with whom they form a group nor their risk-profile.<sup>26</sup>

### 5.2.2 Competitive Insurance and Non-Insurance Markets

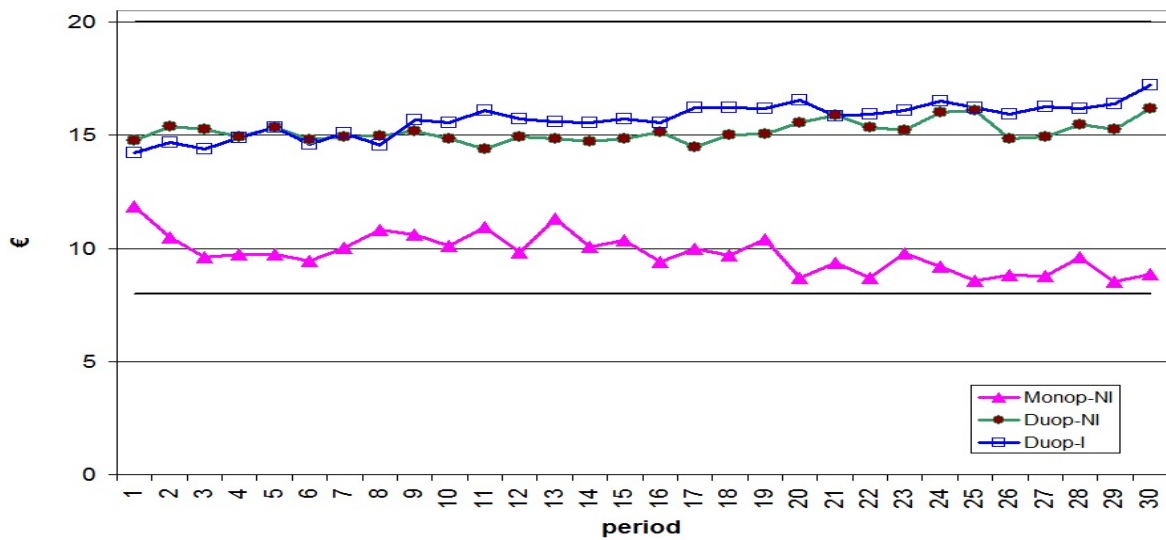
For the duopoly markets, the hypotheses (see Table 2) are that independent of the initial loss size, the introduction of competition should reduce both the expected profits to zero; in the insurance market DUOP-I, premiums should also be zero in equilibrium (with all consumer-subjects preferring coverage over staying uninsured; in DUOP-NI we expect that insurers, in an attempt not to erode the market for insurance, will continue to set the loss size (and thereby the premium) strictly above zero. That is, they will primarily compete in premiums but less in loss sizes.

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<sup>26</sup>Levitt (2006) shows for a real-life situation that firms can have problems in selecting the profit-maximizing price.



(a) Average expected insurer profits.



(b) Average expected consumer earnings.

Figure 9: Per period average expected insurer profits and consumer earnings for MONOP-NI (triangles) and DUOP-NI (circles) and DUOP-I (squares).

**Note:** The expected profits and earnings are calculated assuming that consumers (insured and uninsured) experience a loss with probability  $p = 0.6$ .

**Duop-NI** Figure 8 shows that when compared to MONOP-NI, the introduction of competition leads to significantly lower loss sizes and premiums (see also Table 4). Table 4 and Figure 9 also show that, in line with our hypothesis, insurers are not able to make positive profits in this market ( $p = 0.681$  for the final 15 periods). Figure 9 shows that in time, insurer-subjects learn how to break-even in these markets. Compared to the non-insurance monopoly market, consumers significantly benefit from insurer competition with average expected earnings increasing from about 9 to more than 15.

However, despite competition, the market remains an insurance market: the loss size the uninsured face does not drop to 0 but remains at a significantly higher value of 7.71 ( $p < 0.001$ ).<sup>27</sup> That is, as predicted, competition moves the contingent claim for the insured in Figure 1 from point  $M_L$  to  $C_S$  while the uninsured face contingent claim  $B$ . Importantly, both insured and uninsured consumers are worse off than when they faced the initial state claim  $D$ .

**Duop-I** In the competitive insurance market DUOP-I, uninsured consumers continue to face a loss size of 20 (contingent claim  $A$  in Figure 1). Our hypotheses state that insurer-competition will lead insurers to transfer all advantages of negotiated discounts to their consumers by lowering the premiums up to the point where both premiums and the losses to be recouped by insurers are 0 (point  $D$ ); in equilibrium, all consumers will prefer to buy insurance.

Table 4 and Figure 8c show that throughout, over 95% of all consumer-subjects chooses to buy insurance. This insurance market is a real boon to the insurer-subjects because they quickly learn to set the value of the loss that they have to recoup to zero while, despite competition, they are still able to charge significantly positive premiums of on average 3.54 in the final fifteen periods ( $p < 0.001$ ). Although the premiums do not converge to zero, they are at the 10%-level, significantly lower than in the non-insurance markets DUOP-NI ( $p = 0.083$ ). This difference can be attributed to the threat the insurers in the non-insurance markets DUOP-I face that pushing the loss sizes too low will erode their market. For this reason, they refrain from ‘negotiating’ as fiercely as in treatment DUOP-I. Figure 9b suggests that expected consumer earnings are on average even a bit higher in the competitive insurance market with initial loss size  $L_0 = 20$  but this difference is statistically insignificant.

In sum, in case the potential loss to the uninsured is 20, consumers are clearly better off when

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<sup>27</sup>As one insurer-subject explained in the post-experiment survey [translated from Dutch]: “Because I determined the loss size, I tried to lower this in exchange for a higher premium (such that both I and the consumers would be better off as long as they continued to pay the premium). However, this did not succeed. The temptation for the others not to insure proved too great.”

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, our evidence shows that in markets that are non-insurance markets by nature, the introduction of competition between insurers does not necessarily push premiums and loss sizes back to the initial state: consumer earnings are similar in the competitive non-insurance and insurance markets and in the non-insurance markets, they end up paying even slightly higher premiums to receive coverage. Figure 9a contains an important policy implication: from the observation that insurers in a market do not make profits, one should not conclude that competition forces insurers to do all they can to offer insurance at the lowest possible prices.

## 6 Further checks

In this section, we report some additional analysis on the data that serves as a further check on our results. First, in Section 6.1, we address whether the choices made by consumer-subjects in the risk-elicitation stage are indicative of their behavior in the subsequent market stage. Then, as a check on the external validity of our findings, we investigate in Section 6.2 how the consumer-subjects' elicited risk attitudes relate to insurance purchases they make in every-day life. We collect information on this in an ex post survey. Finally, Section 6.3 considers for insurer-subjects whether there is a relation between their risk-attitudes and the offers made in the market stage.

### 6.1 Consistency Risk Elicitation and Market Stage

Do risk-preferences elicited in the laboratory adequately capture the behavior of an individual in choices under uncertainty outside the lab? The stability of risk preferences across decision contexts is an important and mostly open research question.<sup>28</sup> We zoom in on one particular element of this question: Do subjects exhibit the same attitude towards risk when they are put in a strategic market context instead of an individual risk-elicitation task? We answer this question by consider the consistency between the stage I and II choices of consumer-subjects.

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<sup>28</sup>See the recent survey by Barseghyan *et al.* (2015) and the references therein.

The first part of Table 5 contains the results for risk-elicitation stage. This stage is identical for all treatments such that it is only natural that the average value of the individual risk preference estimates  $\hat{\gamma}_i$  is very similar. We use these estimated  $\gamma_i$ 's to back out for each consumer-subject  $i$  the average difference in the certainty equivalent ( $\Delta CE$ ) between option A and B that he or she is confronted with in Stage I, the mean of these values is reported in Table 5, as is the number of choices between option A and B that is correctly predicted when individual  $i$ 's are represented by utility function (3) with  $\gamma = \hat{\gamma}_i$ . Given that the estimated  $\gamma_i$ 's are similar across treatments and that subjects face the same choice problems, it is not surprising to find that the mean  $\Delta CE$  value and the success rate of the (in-sample) predictions is very similar across treatments with the estimated utility model predicting on average 84% of all choices correctly.

In the market stage, the options A and B are endogenously set by the insurer-subjects. This results in the options consumer-subjects face being less extreme than in the risk elicitation stage. For example, an insurer-subject has no interest offering insurance against a potential loss of 20 at a premium of 2. This is also manifest in Figure 6: the offers of insurers tend to be centered along the risk-neutral line. This implies that one cannot simply do a between-treatment of the success rate of the realized (out-of-sample) predictions for the market stage. For this variable, Table 5 indeed reveals large differences: from 65.2% in MONOP-NI to 95.3% in DUOP-I. The high number in DUOP-I is caused by the presence of the clearly unattractive option of staying uninsured (and facing a potential loss of 20) in the latter treatment. This leads to a large  $\Delta CE$  in evaluating the options and a correspondingly low chance that a subject makes a 'mistake'. As  $\Delta CE$  becomes smaller, the likelihood of the 'mistake' of choosing the less preferred option grows. The small market stage  $\Delta CE$ 's in MONOP-NI and DUOP-NI are indicative of insurer-subjects manoeuvring the premium-loss size combination into a region where consumer-subjects become close to indifferent between whether or not to buy insurance.

For this reason, we correct as follows for between-treatment differences in the  $\Delta CE$  values of the options available to consumers. Conditional on the estimated  $\gamma_i$ 's and  $\tau$ 's and given the value  $\Delta CE_{ij}$  of each offer  $j$  posed to subject  $i$ , we use (9) to calculate the probability that the subject does not make a mistake. We then take for each consumer-subject the average of these probabilities. Averaging over all consumers in a given treatment then gives us the predicted number of correct decisions that takes into account between-treatment differences in the offers consumers face. Table 5 shows that the predicted and actual percentage of correct decisions are relatively close in the duopoly treatments. For MONOP-NI, the table reveals an overprediction

of correct decisions. That is, given their choices in the first stage and the offers they face in the market stage, consumer-subjects seem to make more inconsistent choices than can be explained by random mistakes only.

Table 5: Choices by consumer subjects in the risk elicitation and market stage ( $p = 0.6$ ).

<b>Treatment</b>	<b>MONOP-NI</b>	<b>DUOP-NI</b>	<b>DUOP-I</b>
<b>I. Risk Elicitation Stage</b>			
<b>mean <math>\Delta</math> CE</b>	3.837	3.878	3.879
<b>mean <math>\hat{\gamma}</math></b>	0.081	0.083	0.095
<b>correct decisions</b>	84.1%	83.9%	84.7%
<b>II. Market Stage</b>			
<b>mean <math>\Delta</math> CE</b>	1.550	1.165	11.296
<b>correct decisions (predicted)</b>	73.4%	69.1%	99.1%
<b>correct decisions (realized)</b>	65.2%	72.3%	95.3%
<b>Difference (in perc. points)</b>	-8.2	3.2	-3.8
<b>Incorrect predictions</b>			
<b>insured</b>	45.53%	28.16%	0.00%
<b>uninsured</b>	54.47%	71.84%	100.00%
<b># incorrect predictions</b>	574	309	64
<b>fraction incorrect predictions</b>	0.348	0.258	0.047
<b>obs.</b>	55	40	45

While the difference between the predicted and realized number of correct decisions tells us how well the risk preferences in the first stage predict the actual behavior of consumer-subjects in the market stage, it is not informative about the direction of any bias. To investigate whether people behave more or less risk-averse when put in a market context, we next consider whether the estimated  $\gamma_i$ 's over- or under-predict the demand for insurance in the market stage. To this end, we plot in Figure 10 for each treatment separately the market stage decisions that are inconsistent with the individual risk preferences estimated in Stage I. Panel 10c for example shows that for DUOP-I where the total number of incorrect predictions is very small, they are all in the same direction: consumer-subjects do not buy insurance in choice-situations where they should have given their estimated risk preferences. In other words, they sometimes behave less risk-averse in this particular market context. Also for the other competitive treatment DUOP-NI, 71.8% of all incorrect predictions predict that subjects should have bought insurance whereas in practice they decided to go insured. Figure 10b reveals that in many of these

cases, consumer-subject rejected offers that were actuarially more than fair. In MONOP-NI, the incorrect predictions are rather evenly split between predicting buying insurance when the subject did not and vice versa. Figure 10a also does not reveal a bias in a particular direction.

The main take away is that the elicited risk attitudes predict a consumer’s insurance choices in a market context reasonably well but that they exhibit some inclination to make less averse choices when the insurance market is competitive. Possibly this is caused by the expectation that in a competitive environment playing hard to get is more likely to pay off in the form of receiving more favorable offers in future periods.

## 6.2 Consumer-subjects: Insurance purchases outside the lab

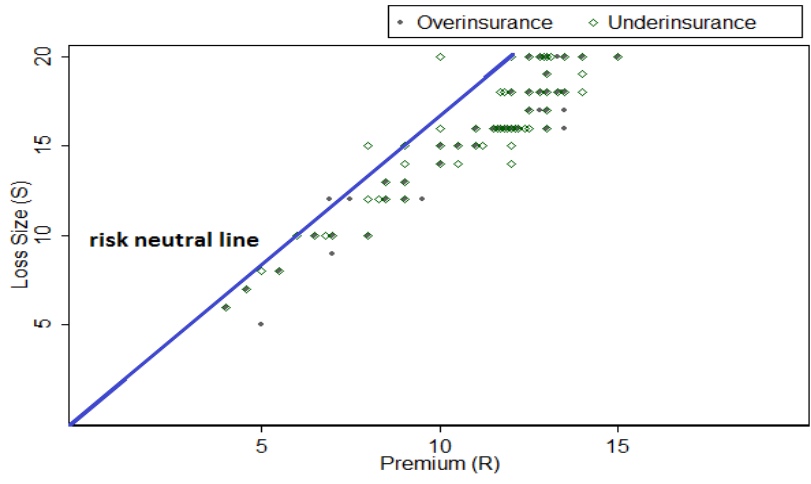
In the short survey administered at the end of the experiment we asked participants whether they were insured against a number of common risks. Our list included comprehensive travel insurance, cancellation insurance, prolonged warranty insurance, dental insurance and personal possessions insurance. Table 6 shows the prevalence of these insurances in our sample.<sup>29</sup> About two-thirds of all subjects indicate to own a Permanent Travel Insurance and Dental Insurance, which makes these the most commonly owned insurance policies in our sample.

Table 6: Insurances owned by subjects (standard deviations within parentheses).

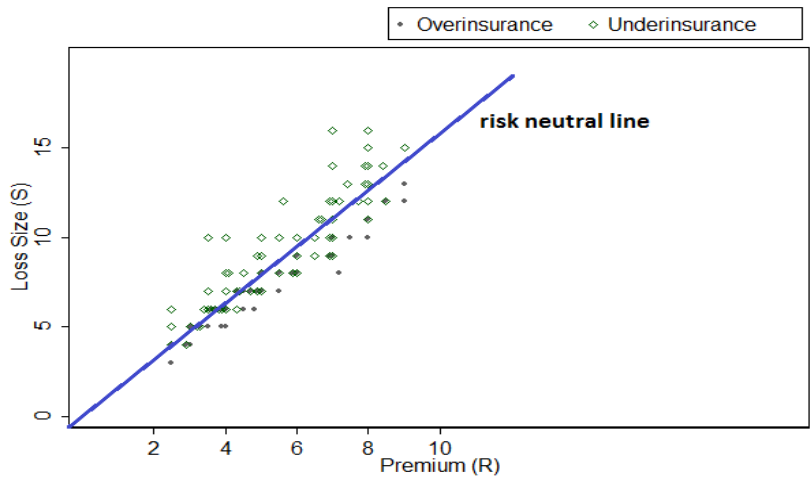
<b>Treatment</b>	MONOP-NI	DUOP-NI	DUOP-I
Permanent Travel Insurance	0.677	0.679	0.769
	(0.471)	(0.471)	(0.425)
obs.	62	53	52
Cancellation Insurance	0.274	0.208	0.365
	(0.37)	(0.285)	(0.455)
obs.	62	53	52
Prolonged Warranty Insurance	0.153	0.123	0.115
	(0.308)	(0.276)	(0.291)
obs.	62	53	52
Dental Insurance	0.774	0.630	0.667
	(0.422)	(0.487)	(0.476)
obs.	62	54	51
Peronal Possessions Insurance	0.071	0.106	0.133
	(0.26)	(0.312)	(0.344)
obs.	56	47	45

To see whether the estimated risk preferences reflect an individual’s subject’s propensity to

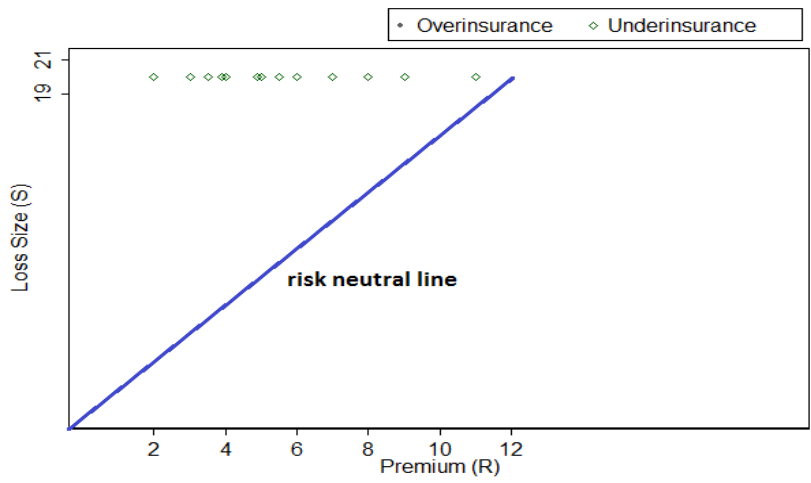
<sup>29</sup>The answer categories are “YES”, “NO” and (for the cancellation and prolonged warranty insurance) “SOMETIMES”. We coded “YES” as 1; “NO” as 0 and “SOMETIMES” as 0.5.



(a) MONOP-NI.



(b) DUOP-NI.



(c) DUOP-I.

Figure 10: Stage II insurance choices inconsistent with estimated Stage I risk preferences.



buy any of the insurances listed in Table 6, Table 7 reports the estimates of a regression of the  $\hat{\gamma}_i$ 's on dummy variables for owning any of these. The results show that the insurance dummies are jointly insignificant. At first sight, the absence of a risk-coverage correlation may be surprising but it isn't once one realizes that equilibrium insurance premiums are influenced by a myriad of other factors including adverse selection (Chiappori and Salanié, 2014).<sup>30</sup>

A final issue to consider is whether the insurance policies participants buy outside the lab have, next to the  $\gamma_i$ 's estimated in the first stage, any predictive value in predicting subject's insurance choices in the market stage of the experiment. To this end, Table 8 reports for each treatment the results of a probit regression of a dummy variable indicating whether insurance was bought in the market stage on a number of explanatory variables. As expected, the probability of buying insurance is positively correlated with an individual's degree of risk aversion, negatively correlated with the premium one needs to pay for the insurance and positively dependent on the potential loss faced when uninsured.<sup>31</sup>  $F$ -tests reveal that in DUOP-NI, the dummy variables on insurances owned are statistically significant at the 5% level. However, from the sign of the individual coefficients, no clear picture emerges about how, next to knowing a person's risk attitudes as represented by  $\hat{\gamma}_i$ , a consideration of an individual's actual purchases informs the experimenter about the subject's choices in the market stage.

### 6.3 Insurer-subjects: Risk attitudes and offers

One motivation for our introduction of the payoff structure where we pay insurer-subjects in the market stage 10% of their accumulated profits is that this may induce them to behave more risk-neutral because it reduces the impact of individual random draws (determining the loss of an insured consumer) on their final earnings. To see whether this approach has been successful, Figure 11 plots for each experimental market the average minimum premium at which insurance was offered against the estimated individual risk-preference parameter of the insurer-subjects in that market. In DUOP-I, the minimum market premium however seems to be negatively related to the private risk preferences of the insurers offering the premium. A simple regression confirms this ( $\beta = -12.96$ ;  $p = 0.011$ ;  $n = 18$ ). A somewhat similar tendency is observed in MONOP-NI ( $\beta = -12.31$ ;  $p = 0.237$ ;  $n = 11$ ) but not in DUOP-NI ( $\beta = -0.42$ ;  $p = 0.679$ ;  $n = 16$ ).

We established (Figure 9a) that selling insurance in MONOP-NI and DUOP-I is far more

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<sup>30</sup>Cohen and Siegelmann (2010, p. 62) notice that "A riskcoverage correlation appears to be a feature of some insurance markets or pools of insurance policies but not of others." See also Ericson *et al.* (2015).

<sup>31</sup>In Duop-I the estimated relations are less clear-cut due to the high overall (> 95%) take-up rate.

Table 7: Relation Stage I risk preferences and outside lab insurance choices.

Dependent variable	$\hat{\gamma}_i$
Permanent Travel Insurance	0.043* (0.025)
Dental Insurance	0.01 (0.024)
Cancellation Insurance	-0.044 (0.032)
Prolonged Warranty Insurance	-0.02 (0.045)
Personal Possessions Insurance	0.017 (0.041)
constant	0.082***
<i>Probability F test</i>	
insurance dummies	0.439
$R^2$	0.033
obs.	148

profitable than in DUOP-NI. For this reason, one possible reading of the relation between market premiums and insurer risk preferences shown in Figure 11 is that a higher degree of risk aversion is correlated with a higher eagerness/impatience to make a sale. So insurers in these treatments may not act fully independent of their private risk-preferences. For our experimental findings, this means that the minimum premiums reported in Table 4 may underestimate the equilibrium values that would obtain in a setting with risk-neutral insurers selecting the offers (as we expect actual insurance firms to do).<sup>32</sup>

## 7 Summary and conclusions

The question how concentration in downstream markets enables buyers to effectively improve their bargaining position in price negotiations with service suppliers continues to be complex. This paper argues that this is especially true in markets where the buyers consist of insurance companies who negotiate on behalf of their customers. Existing empirical studies focus on the relation between competition intensity in the up- and downstream market and the negotiated prices but mostly take the costs of the upstream firms as given. We emphasize that when insurers can use their bargaining cloud not only to arrive at better prices but also to influence the cost

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<sup>32</sup>A more general implication is that inferences from laboratory experiments on Bertrand competition using pools with risk-averse subjects may overstate the competitiveness of real-life markets in which risk-neutral firms compete in prices. This is a topic that deserves further research.

Table 8: Relation Stage II and outside lab insurance choices.

<b>Treatment</b>	MONOP-NI	DUOP-NI	DUOP-I
<i>Estimated risk preferences</i>			
$\hat{\gamma}_i$	1.611*** (0.518)	0.668** (0.278)	0.019 (0.043)
<i>Participant characteristics</i>			
female	0.246*** (0.078)	-0.088 (0.067)	0.004 (0.011)
age	-0.075 (0.101)	-0.031 (0.223)	-0.052 (0.037)
age <sup>2</sup>	0.002 (0.002)	0 (0.005)	0.001 (0.001)
minimum market premium	-0.102*** (0.031)	-0.309*** (0.035)	-0.005*** (0.004)
potential loss uninsured	0.094*** (0.022)	0.209*** (0.023)	- (-)
<i>Insurances owned</i>			
Travel Risk Insurance	0.198* (0.1)	0.168** (0.081)	-0.008 (0.01)
Dental Insurance	0.095 (0.081)	0.13* (0.068)	-0.019*** (0.014)
Cancellation Insurance	-0.065 (0.111)	-0.311** (0.129)	0.019 (0.013)
Extended Health Insurance	0.2 (0.132)	-0.166 (0.142)	-0.013 (0.024)
Peronal Possessions Insurance	0.077 (0.116)	-0.008 (0.116)	0.01 (0.006)
<i>Probability F tests</i>			
insurance dummies	0.1681	0.0131	0.1713
Loglikelihood	-802.92	-487.02	-127.49
pseudo $R^2$	0.1389	0.2434	0.2124
obs.	1350	930	930

**Notes:** Marginal effects reported; errors clustered at the subject level; standard errors in parentheses; \*\*\*(\*\*/\*) denotes significance at the 1% (5%/10%) level.

structure in upstream markets, this not necessarily leads to lower costs when lower costs imply that the uninsured face lower potential losses. Indeed, decreases in the potential loss reduces the demand for insurance by risk-averse consumers, posing a direct threat to the *raison d'être* of the insurer.

We use theory and empirical illustrations to convey how insurers might successfully apply this mechanism in practice and we present experimental evidence showing that insurer-subjects

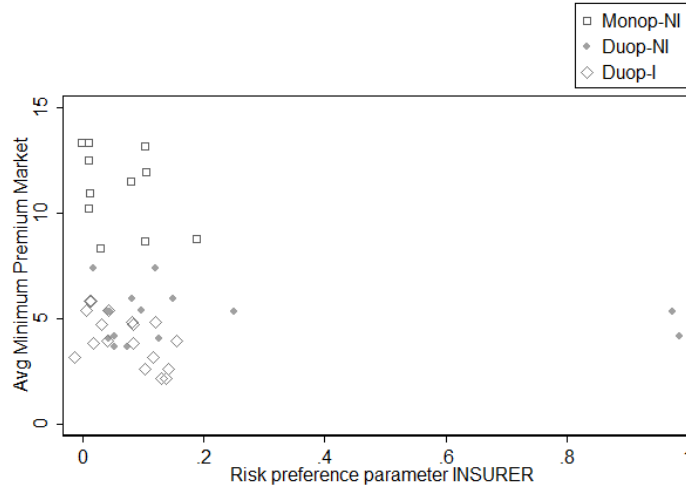


Figure 11: Relation between the estimated risk preferences of insurer-subjects and the average minimum premium established in their markets.

in the lab routinely move away from the non-insurance outcome because they recognize the threat of potential losses that are too low for consumers to buy insurance. The introduction of insurer competition does not change this outcome although it does annihilate the insurers' profits.

We believe that this research contains an important policy implication and an illustration of a common misconception. It is beyond doubt that insurances increase welfare by their risk-sharing properties in markets that we characterize as natural insurance markets. However, in granting insurers buyer-power as a counterweight to supplier market power, regulators should pay attention that insurers do not abuse this power to protect insurance markets or to create them in those realms of life that are non-insurance markets by nature. This may for example happen when their market power enables insurers to block the introduction of cost-saving technologies, the entry of cheaper suppliers or by stimulating service suppliers to bundle different services into a more expensive product.

In our experimental markets, insurer competition drives their profits to zero. However, our results also show that based on this statistic alone, one should not conclude that competition guarantees consumers the lowest possible prices because loss sizes are still far above the zero lower bound and even somewhat higher than in markets that are insurance markets by nature. Our findings suggest that competitive forces primarily induce insurers to decrease premiums to the actuarially fair rate for a given loss size but that they are wary to curb the loss sizes.

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## A Proofs

### A.1 Proof of Proposition 1

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

□

### A.2 Proof of Proposition 2

In what follows, we assume risk-averse consumers have homogenous risk preferences such that we can normalize the number of consumers without loss of generality to  $n = 1$ . Besides the premium, consumers have to incur a transaction cost  $c$  when buying insurance such that they only buy insurance if the potential loss  $L \geq \underline{L}(c)$ .  $\underline{L}(0) = 0$ . We assume that the uninsured face a potential loss  $L \in [\underline{L}(c), +\infty)$ . The proof is in three steps.

- a First, in equilibrium  $R_1 = R_2 \leq W - CE(L)$ , i.e. both insurers must charge an identical premium. For suppose that, say,  $R_1 > R_2 > pL_2$ , then  $E[\pi_2] > 0$  and  $E[\pi_1] = 0$  because insurer 1 would not have any clients. Insurer 1 could strictly improve by setting  $R_1 = R_2$  (and  $L_1 = L_2$ ) which would render insurer 1 half of market demand and expected profits  $E[\pi_1] = E[\pi_2]/2 > 0$ .
- b Second, in equilibrium, the premium by both insurers has to satisfy  $R_i = pL_i$  for  $i = 1, 2$ . That is, the expected profits  $E[\pi_i]$  equal zero for both insurers. For suppose that  $R_2 = R_1 > pL_1$ . Then, insurer 1 can strictly increase its expected profits by reducing the premium by an amount  $\epsilon$ , with  $0 < \epsilon < (R_1 - pL_1)/2$ . By undercutting his competitor, he no longer has to share the market and  $E[\pi_1^{New}] = (R_1 - \epsilon) - pL_1 > (R_1 - pL_1)/2 = E[\pi_1]$ .
- c Finally, we prove that in equilibrium  $L_1 = L_2 = 0$ , that is: independent of the loss  $L > \underline{L}(c)$  faced by the uninsured, the insurers will reduce the cost they have to pay when one of their customers faces a loss to 0. From b), we know that  $L_1 = L_2$ . Now suppose that  $L_1 = L_2 = \tilde{L} > 0$ . Then there exists a value  $L^{New}$  with  $0 < L^{New} < \tilde{L}$  such that if, say insurer 1, sets  $L_1 = L^{New}$  and  $R(L^{New}) = W - CE(L^{New})$ , he will reap positive profits.

Because  $R(L)$  is increasing in  $L$  and  $R(0) = 0$ , for  $L^{New}$  sufficiently small,  $R(L^{New}) < p\tilde{L}$ : all consumers prefer insurance by firm 1 to insurance by firm 2 or staying uninsured.  $\square$

## A.3 Numerical Example

### A.3.1 Separate Evaluation Purchase and Insurance Decision

Consider the market described in Section 2.2. A monopolistic firm can supply two versions of a particular product, one with quality  $q_L$  and the other with quality  $q_H > q_L$ . The constant marginal cost of supplying version  $i \in \{L, H\}$  is  $c_i$ . Consumers differ in their taste for quality  $\theta$  with a fraction  $\lambda$  (the ‘high types’) having taste parameter  $\theta_H$  and the remaining fraction  $1 - \lambda$  (the low types),  $\theta_L < \theta_H$ . Consumers receive a surplus  $U = \theta q - x$  if they buy a product of quality  $q$  at price  $x$ .

In what follows, we take the parameter values  $c_L = 0.10$ ;  $c_H = 0.15$ ;  $\theta_L = 0.3$ ;  $\theta_H = 0.6$ ;  $q_L = 0.6$ ;  $q_H = 0.8$ ;  $\lambda = 0.3$ ;  $p = 0.3$  and  $\gamma = 0.9$ . We consider three cases: *a.* only quality  $q_L$  is supplied; *b.* only quality  $q_H$  is supplied, and, *c.* both qualities are supplied.

**a. Only quality  $q_L$  is supplied** The supplier can decide to sell to both types of consumers, in which case he sets a price  $p_L^* = \theta_L q_L = 0.3 \cdot 0.6 = 0.18$  and his profits equal  $\pi = \theta_L q_L - c_L = 0.18 - 0.08$ , or only to the high types at price  $p_L^* = \theta_H q_L = 0.36$  giving profits  $\tilde{\pi} = (\theta_H q_L - c_H)\lambda = (0.36 - 0.15)0.3 = 0.078$ .

**b. Only quality  $q_H$  is supplied** If the supplier sells the high quality good to both consumers, he cannot charge more than  $p_H^* = \theta_L q_H = 0.24$ , leading to profits  $\pi = 0.09$ . In this case, it is more profitable to sell only to the high types at price  $p_H^* = \theta_H q_H = 0.48$ , giving profits  $\hat{\pi} = 0.099$ .

**c. Both qualities are supplied** If both qualities are supplied, one needs to ensure that both types buy the good that is designed for them. The low quality product is priced at  $p_L^* = \theta_L q_L = 0.18$ . To induce the high types to buy the high quality product, the incentive compatibility constraint  $\theta_H q_H - p_H \geq \theta_H q_L - p_L$  needs to be satisfied. This holds for

$$p_H^* = p_L^* + (q_H - q_L)\theta_H,$$

see Tirole (1988, p. 153), for the given parameter values  $p_H^* = 0.30$  and  $\pi_{LH}^* = 0.7(0.18 - 0.10) + 0.3(0.30 - 0.15) = 0.101$ . This is highest profit that can be obtained such that in isolation, a



profit-maximizing supplier would decide to supply both goods.

**The insurance decision** Once the consumer has bought the good at price  $x$ , he faces a potential loss of  $x$ . Suppose that he is risk averse with CARA exponential utility function  $u(w) = 1 - e^{-\gamma w}$  with  $w$  denoting his wealth level and  $\gamma$  the parameter of risk aversion. The inverse of this function is  $u^{-1}(y) = -\ln(1 - y)/\gamma$ . The insurance premium  $R(x)$  for which

$$u(w - R(x)) = pu(w - x) + (1 - p)u(w).$$

is by definition the premium that makes this consumer indifferent between buying insurance and staying uninsured. For our utility specification, we can solve for  $R(x)$ :

$$R(x) = \ln 1 - p + pe^{\gamma x}/\gamma. \tag{A.1}$$

The insurers expected profits from selling one insurance policy to recoup the loss of  $x$  at a premium  $R(x)$  are

$$E[\pi_{INS}] = R(x) - px.$$

For the given parameters, the insurer's total expected profits when both products are supplied are:  $E[\pi_{INS}^{LH}] = (1 - \lambda)(R(p_L) - p \cdot p_L) + \lambda(R(p_H) - p \cdot p_H) = 0.7(0.057 - 0.3 \cdot 0.18) + 0.3(0.099 - 0.3 \cdot 0.3) \approx 0.0048$ . However, the insurer attains higher expected profits when only the high quality is supplied to the high types. Then,  $E[\pi_{INS}^H] = \lambda(R(p_H) - p \cdot p_H) = 0.3(0.167 - 0.3 \cdot 0.48) \approx 0.0069$ . In other words, the insurer has an incentive to press the supplier to stop offering the low quality product. Moreover, in the case at hand, with 0.10588 the joint profits of the supplier and insurer when only the high quality product is offered are higher than the combined profits of 0.10583 when both products are supplied. This implies that the insurer can reimburse the supplier for any profits lost from not supplying the low quality version and still benefit.

### A.3.2 Simultaneous Evaluation Purchase and Insurance Decision

Now consider the case where the consumer does not separate the purchase and insurance decision. That is, at the time of purchase he is aware that buying the product involves a risk which entails that now or at some future moment he will buy against this risk. This implies that his willingness to pay for the product reduces to  $x$  defined by the implicit function  $x = \theta q - R(x)$ . An approximate solution for  $x$  can be obtained by using (A.1), take exponentials of the left- and right-hand side and use a second-order Taylor approximation for the exponential functions in

the resulting equation. The approximate solution  $x^* = (-b - \sqrt{b^2 - 4ac})/2a$ , with  $a = \gamma^2(1 - p)$ ;  $b = -\gamma(1 + p + 2\gamma\theta q)$ , and  $c = \gamma\theta q(1 + \gamma\theta q)$ .

In this case and for the given parameter values, the insurer's expected profits are still higher when only the high quality product is supplied but offering both maximizes the combined profits of the insurer and supplier.

## B Additional Tables and Figures

Table B.1: Sessions summary

Loss size ( $L$ )		Fixed	Fixed	Free	Free	Free	Free
Loss probability ( $p$ )		0.2	0.6	0.2	0.6	0.6	0.6
Insurance market? ( $L_0$ )				0	0	20	0
Competition		MON	MON	MON	MON	DUOP	DUOP
Session	# mkts.						
1	Mar. 21, 2012	4	x				
2	Mar. 22, 2012	3	x				
3	Mar. 22, 2012	3		x			
4	Mar. 23, 2012	3			x		
5	Mar. 23, 2012	2				x	
6	Jun. 20, 2012	4				x	
7	Jun. 20, 2012	3		x			
8	Nov. 19, 2012	3			x		
9	Nov. 20, 2012	5	x				
10	Nov. 21, 2012	4		x			
11	Nov. 21, 2012	5				x	
12	Nov. 23, 2012	4		x			
13	Apr. 11, 2013	3				x	
14	Apr. 11, 2013	3					x
15	Apr. 12, 2013	2					x
16	Apr. 12, 2013	3				x	
17	Sep. 30, 2013	2				x	
18	Sep. 30, 2013	1				x	
19	Oct. 01, 2013	2					x
20	Oct. 03, 2013	1					x
<b>Total # of markets:</b>	<b>60</b>	<b>12</b>	<b>10</b>	<b>10</b>	<b>11</b>	<b>9</b>	<b>8</b>
<b>Total # of subjects:</b>	<b>377</b>	<b>72</b>	<b>60</b>	<b>60</b>	<b>66</b>	<b>63</b>	<b>56</b>

**Note:**

In the sessions with fixed loss sizes, the following orders were implemented in the periods [1 – 15]/[16 – 30]:  
 Session 1: 16/4, 4/16, 8/20; Session 2: 12/20, 20/12, 12/4; Session 3: 12/20, 20/12, 12/4;  
 Session 8: 4/16, 8/20; Session 9: 4/16, 4/12, 12/4, 12/20, 20/12;  
 Session 10: 8/20, 12/4, 12/20, 4/12.



(a) Traditional Dutch bicycle.



(b) Modern electric bicycle.

Figure B.1: Traditional and electric bicycles.

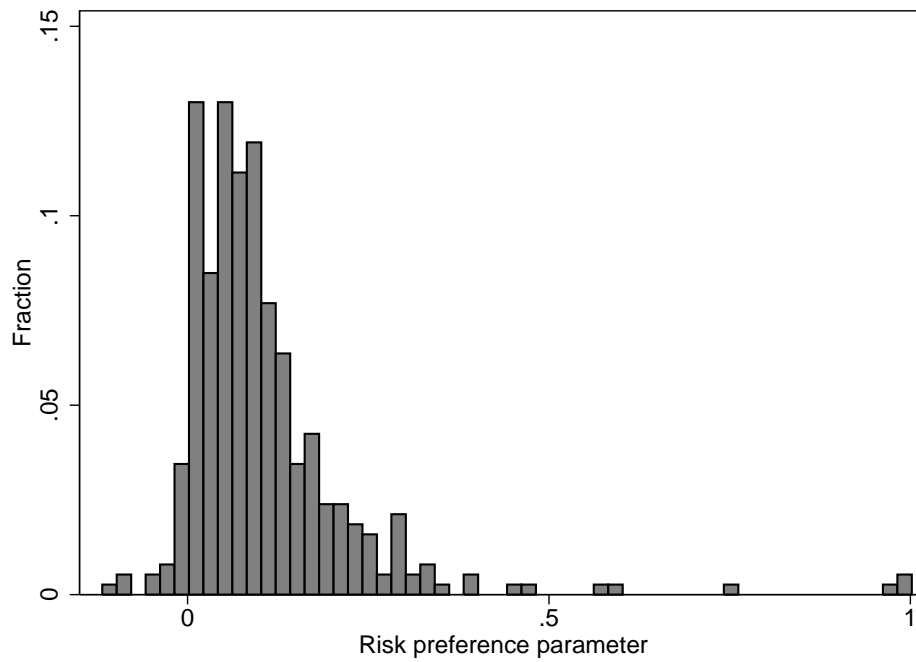


Figure B.2: Distribution of estimated risk aversion parameters  $\gamma$  (All sessions).



## List of research reports

12001-HRM&OB: Veltrop, D.B., C.L.M. Hermes, T.J.B.M. Postma and J. de Haan, A Tale of Two Factions: Exploring the Relationship between Factional Faultlines and Conflict Management in Pension Fund Boards

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