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(NON-)INSURANCE MARKETS, LOSS SIZE MANIPULATION AND COMPETITION: EXPERIMENTAL EVIDENCE*

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The common view that insurer buyer power may effectively counteract provider market power critically rests on the idea that consumers and insurers have a joint interest in pushing for price and cost reductions. We develop theory and provide experimental evidence that the interests of insurers and consumers may be misaligned when insurers have the power to influence the service supplier's cost. Insurers with such buyer power may benefit from increasing initial loss sizes to create demand for insurance. Insurer competition eliminates their profits but markets do not return to the initial non-insurance state. This constitutes a welfare loss.

I. 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 may benefit consumers. In dividing the given surplus of a transaction, large buyers may negotiate a larger share in the form of price discounts relative to smaller buyers.¹ In addition, buyer power may increase the surplus to be divided due to

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¹ A possible reason for getting a better deal in intermediate goods markets is that large buyers may have better outside options (Katz, [1987]; Scheffman and Spiller, [1992]).

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transaction-specific efficiencies related to the buyer's being large, for example when the per unit distribution costs of serving a large buyer are lower. In both cases, consumers benefit when these negotiated discounts are passed on to them. This possibility has been used to justify buyer power in intermediate goods markets, but also in insurance markets where the buyers are insurers who bargain with service suppliers about the price to redress a loss.

However, an insurer has less interest in reducing unit cost beyond the transaction-specific efficiencies when the reduction in cost to redress a loss decreases consumers' demand for insurance. Given risk-averse consumers, the positive dependence between the insurer's expected profits and the loss size uninsured consumers face puts natural limits on the insurer's incentives to pursue lower loss sizes. An insurer who very successfully reduces the potential loss consumers face possibly erodes his own market because consumers may no longer bother to buy insurance once the downside is negligible. Instead, insurers may use their clout to influence input prices to raise loss sizes in order to increase demand for their product and to create insurance markets. This is in contrast to intermediate goods markets where demand is a function of final good prices only. In those markets a reduction in the supplier's unit cost unambiguously increases the size of the surplus to be split between buyer and seller, which also benefits consumers if (part of) the surplus increase is passed on to them.

Attention to this dimension of insurance markets has been scant, with the exception of the theoretical contributions by Schlesinger and Venezian [1986, 1990]. They study an insurer's loss control strategies but restrict the insurer's strategy set to loss prevention (reducing the loss probability) and loss reduction (reducing the loss size) activities prior to the sale of insurance. They neglect the possibility that an insurer would act to the detriment of consumers, arguing that [1986, p. 232]: '*... such action is likely to meet with resistance from the individual (...) as well as from insurance regulators.*' Given the possibilities of covering up such activities, we are less sanguine about this possibility and explicitly allow for insurers to increase loss sizes, both in our theoretical and experimental analysis.

For example, under the guise of increasing quality for their insured base, insurers may press suppliers to deliver more expensive services that also increase the loss size uninsured consumers face. Section III presents a theoretical argument for how granting insurers the power to influence loss sizes may lead to the eradication of cheaper, lower quality alternatives. In practice, influencing suppliers' loss sizes may operate by introducing a network of preferred suppliers that satisfy certain quality standards. Another real-world mechanism that may operate is when suppliers such as hospitals increase the list prices of treatments in anticipation of the ensuing bargaining process with insurers. Higher list prices improve their bargaining position. However, insurers may not object to this as they can negotiate discounts for their clients while the uninsured continue to face the higher list prices. Individuals who

are sufficiently close to risk neutrality to pass on insurance with cost-based list pricing will buy insurance at these higher prices.²

These examples illustrate two important points. First, the difficulty of finding hard evidence of this mechanism operating in the real world: The loss size that would prevail without insurer intervention (the market's 'initial loss size' L_0) is an unobserved counterfactual, and loss size increases that are justified by actual improvements in product or service quality are hard to distinguish from those that do not constitute an actual improvement. Second, the insurer's incentives to reduce the supplier's cost critically depend on whether such reductions also benefit the uninsured in the form of lower loss sizes. In case the uninsured and insured face the same price to redress a loss, the insurer's incentives are misaligned with those of suppliers and consumers. Throughout, we shall refer to this situation as the 'uniform loss' (UL) case. The other situation, where the negotiated loss sizes are exclusively available to insurees while the uninsured continue to face the initial loss size, is labeled the 'loss discrimination' (LD) case.³

To evaluate the social welfare implications of granting insurers the power to influence loss sizes, we categorize markets into insurance and non-insurance markets based on the initial loss size L_0 . We define a market 'an insurance market' when the initial loss size L_0 is sufficiently large for risk-averse consumers to prefer buying insurance over staying uninsured when the insurance is priced at actuarially fair rates. That is, L_0 meets some threshold level L_c . A 'non-insurance market' is characterized by initial loss sizes $L_0 < L_c$. 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.

We make two main contributions. First, in Section II we outline the implications of insurer risk manipulation for loss sizes, insurance premiums, insurance demand and social welfare in a state-preference framework (Arrow [1964]). We consider the uniform loss case and the case where the insurer can loss discriminate. Moreover, we analyze how these outcomes change when the market for insurance is a duopoly. Second, we take our theoretical predictions to the lab (Sections IV–VI). We report the results of a number of experiments designed to investigate under which market conditions insurers can tweak the risk to which the uninsured are exposed to their own benefit, but possibly to the consumers' disadvantage.⁴ For our purposes, one obvious advantage of conducting an experiment over analyzing empirical data is that we can observe market outcomes under different buyer power regimes and market structures, while keeping everything else fixed.

² We thank the Editor for raising this point.

³ In this vein, Schlesinger and Venzian [1986, 1990] analyze the uniform loss case.

⁴ This risk manipulation can in principle take either the form of increasing the probability of a loss or the size of a potential loss; this paper focuses on the latter. Indeed, experimental subjects are known to have difficulties with correctly evaluating probabilities, a complication that our setup avoids.

We show that in non-insurance markets, insurers are best off when uninsured consumers face the highest possible potential loss ($L^U = L_{Max}$), both in the loss discrimination as in the uniform loss case (Proposition 1). Next, we show (Proposition 2) that insurer competition erodes profits by pushing premiums to the actuarially fair rate but does not lead the market to return to the initial state where potential losses are sufficiently small for consumers not to buy insurance. That is, the transformation of a non-insurance market into an insurance market results in an irreversible welfare loss. A markedly different picture emerges in markets that are insurance markets by nature ($L_0 \geq L_c$). In these markets, competition also erodes insurer profits, but in their quest for lower premiums insurers will push the suppliers' prices all the way down to the lowest level L_c at which the market for insurance continues to exist, greatly benefiting insureds. In the uniform loss case, all individuals are predicted to face loss size L_c . In case of loss discrimination, the uninsured are predicted to face the maximal loss size $L^U = L_{Max}$, while the insurers negotiate a zero price $L^I = 0$ to redress losses experienced by their customers. In both cases, consumers have a (weak) preference to buy insurance in equilibrium. However, they are better off with loss discrimination because of the zero insurance premium.

Our experimental markets consist of five consumers and one (monopoly treatment) or two (duopoly treatments) insurers. The second treatment variation is that we vary whether or not insurers can loss discriminate between insured and uninsured consumers.⁵ Service-suppliers are only implicitly introduced: In setting loss sizes, the insurer(s) completely determine prices in the upstream market.⁶ The monopoly treatment (MONOP_{UL}) examines whether insurer-subjects with loss-manipulating power but without loss-discriminating power seize the opportunity to increase the potential loss. The duopoly treatments study the premium and loss size setting strategy of competing insurers in a context with (DUOP_{LD}) and without (DUOP_{UL}) loss discrimination possibilities. This allows us to test our second prediction that competition will benefit consumers in insurance markets, especially when combined with loss discrimination opportunities, but that these benefits are limited in non-insurance markets. In each period, consumer-subjects receive an endowment of €20 but they may lose part or all of this endowment with a given probability. The insurer(s) decide on the amount at risk (the potential loss size) and set(s) a premium. Consumers subsequently make the binary decision to insure (that is, to pay the premium to the insurer), or to go

⁵ One advantage of turning to the lab is that we can use standard risk elicitation methods to measure the risk preferences of market participants. This enables us to rule out any differences in outcomes between markets that result from unobserved differences in risk attitudes.

⁶ One can think of this set-up as the situation where insurers are vertically integrated with the upstream market, or where insurers have the power to block cost-saving technologies or the entry by cheaper suppliers.

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 treatment MONOP_{UL} seize the opportunity to manipulate losses and set an average loss size of €16.44, which is reasonably close to the maximum of €20.⁷ Given a loss probability of 60%, the accompanying premium of on average €11.59 more than compensates for any expected losses. Consumers earn an average surplus of €9.22. For them, this is (by definition) worse than what they could obtain in a non-insurance market, but an improvement when compared with an insurance market with a maximal loss size of $L_{Max} = €20$.⁸ Second, insurer competition reduces the average insurance premiums in both duopoly treatments. They remain somewhat higher in DUOP_{UL} than in DUOP_{LD} (respectively €4.99 and €3.54, $p = 0.083$). In neither treatment do losses reverse to a non-insurance state where consumers do not face any loss. In the uniform loss markets DUOP_{UL} , uninsured consumers face a still sizeable loss size of on average €7.71. This can be attributed to the threat to insurers that their market could be eaten away if loss sizes become too small. In the markets with loss discrimination (DUOP_{LD}), non-insured consumers face by definition a potential loss of $L^U = €20$. For this reason, almost all (>95%) consumers take out insurance. Despite the somewhat lower premium, insurers are the prime benefactors from loss discrimination. Whereas their profits are wiped out by competition in the uniform case DUOP_{UL} (-€0.12 per period), they remain highly profitable in DUOP_{LD} (€7.27 per period) because they can ‘negotiate’ very low prices L^I to redress losses experienced by their clients. Despite the fact that competition significantly increases average consumer surplus, both in DUOP_{UL} (€15.36) and in DUOP_{LD} (€16.21), and that insurer profits are wiped out in DUOP_{UL} , loss sizes are not pushed down to zero and markets remain insurance markets.

This study contributes to the wider literature on buyer power. 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 (Sorensen [2003]; Lakdawalla and Yin [2015]; Trish and Herring [2015]; Ho and Lee [2017]). These studies illustrate that the relation between service supplier concentration and insurer countervailing power on negotiated prices, premiums and welfare is complex.⁹ An important fea-

⁷ The difference of €3.56 compares well with the 28% of the initial endowment that dictator-subjects leave on the table in dictator games (Engel [2011]).

⁸ In the latter case, the expected surplus = $(1-0.6) \times €20 = €8$.

⁹ Snyder [2008] reviews the literature 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.’

ture that distinguishes all these studies from ours is that they take as given the risk and, consequently, the demand for insurance, and focus on how either supplier and/or buyer concentration influences the outcome of the bargaining game over a given surplus.

Finally, 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 rule out that between-treatment heterogeneity in consumer risk preferences is driving our results.¹⁰ To that end, the second-stage market game is preceded by a risk-elicitation stage in which we elicit and estimate individual risk preferences using the multiple price list methodology. We find that choices in the risk elicitation task predict consumer-subjects' insurance choices in the strategic market context reasonably well, except that they exhibit some inclination to make less risk averse choices when the insurance market is competitive.

II. 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.¹¹ The two possible states of nature, a good state W_g and a bad state W_b , are 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. 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.¹²

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. In the real world, people tend not to insure against modest risks like, e.g., the loss of an umbrella for (a combination of) two reasons: a) the transaction cost exceeds the benefits; b) individuals are risk-neutral or risk-loving with regard to modest risks, especially if these losses are framed in the loss domain (Kahneman and Tversky

¹⁰ Note that our experimental markets are relatively thin such that an insurer who is randomly assigned more risk-averse consumers is able to attain higher profits.

¹¹ We assume homogenous risk preferences for ease of exposition. In the empirical analysis of the experiment we relax this assumption and allow heterogeneity in consumers' attitudes towards risk.

¹² 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
[Colour figure can be viewed at wileyonlinelibrary.com]

[1979]). In our model, both reasons are captured by a single parameter c .¹³ This transaction cost parameter thus represents the joint effect of actual transaction cost and of a risk neutral (or even risk loving) attitude over small to modest risks. In the latter case, the positive transaction *cost* actually is a reduction in insurance *benefits* due to a different risk attitude.¹⁴

If the consumer faces a positive transaction cost c , the market will continue to be a non-insurance market for all initial loss sizes $L_0 < L_c$ for which the certainty equivalent $CE(L_0)$ is such that $U(CE(L_0)) = U(W - pL_0 - c) < pU(W - L_0) + (1 - p)U(W)$. For $L_0 = L_c$,

¹³ As is common in modeling markets for risk (see, e.g., Eeckhoudt, Gollier and Schlesinger [2005]) we present our ideas using expected utility theory (EUT) because it is tractable and allows for a mathematically elegant representation within the state-claims space. However, EUT does not allow individuals to have a different attitude towards modest risks as opposed to sizable risks: risk-averse individuals within EUT will insure against any arbitrary small risk when offered at actuarially fair prices. Despite these and other limitations of EUT (Rabin [2000]) we decided to incorporate the different risk attitude for small (risk neutral) and large (risk averse) risks with the EUT framework by introducing the transaction cost parameter. Alternatively, we could have decided to explicitly endow agents with different risk attitudes for small and large risks but this would importantly complicate the exposition without offering additional insights.

¹⁴ In the experiment, transaction costs are virtually absent so reason a) is unlikely to play a role in a participant's decision not to insure. Reason b) continues to be a potential reason for lab-participants not to insure.

the left-hand side of this inequality corresponds to point M_c in Figure 1, the right-hand side to point B . The market is a non-insurance market for all initial loss sizes $L_0 < L_c$, because the transaction cost exceeds a monopolistic insurer's profit margin ($\pi_{M_c} < c$).

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 π_{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.

Proposition 1. When consumers are risk averse, the expected profits of a 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 M_L) and staying uninsured (contingent claim A). Without the possibility to loss discriminate between the insured and uninsured (uniform loss case), the insurer's expected profits are π_{M_L} on each policy sold. Adding the possibility to loss discriminate, 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 further increases his profits: in the most extreme case he negotiates a price of zero 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 D and the insurance market is fully eroded. In case of exclusive deals and no competition, the insurer has no incentive to pass more than an infinitesimally small part of the negotiated discounts to its insured consumers, such that consumers have a slight preference for buying insurance (point M_L) to staying uninsured (point A).

In sum, when the initial loss size $L_0 = L_L$, the presence of a monopolistic insurer neither benefits consumers nor wreaks havoc on their welfare. When $L_0 < L_L$, consumers may experience a loss (gain) in welfare when insurers attempt to increase (decrease) the loss size.

II(i). *Competition in the Insurance Market*

How does competition in the market for insurance affect these outcomes? Absent loss manipulating 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 C_L instead of M_L .

What if the insurers compete for consumers but each have loss manipulating power towards suppliers? Is this the best of worlds that brings consumers back to point D ? This critically depends on whether negotiated discounts also become available to uninsured consumers. In case of loss discrimination, 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 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 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 exogenous potential loss $L \geq L_c$ faced by the uninsured.

However, in the uniform loss case, the negotiated deals are also available to the non-insured. Competitive insurers with loss size setting power will only push back the loss size to $L_1 = L_2 = L_c$ as lower loss sizes erode their market. In equilibrium, consumers are indifferent between buying insurance (point C_D) or not (point B) while insurers' profits again equal zero. Notably, the market remains an insurance market and consumers are worse off than at point D .¹⁵

III. AN ILLUSTRATIVE EXAMPLE

As indicated, loss size manipulation is hard to identify in practice because the initial loss size L_0 is unobserved. To illustrate how loss size manipulation may function, we provide a stylized and a practical example how efforts to counteract supplier market power with insurer market power may backfire. Both consider the situation where insurers cannot loss discriminate.

III(i). *Quality Differences*

Consider a product market with a monopolistic firm that supplies two vertically differentiated versions of a particular product, a version of quality q_L

¹⁵ The equilibrium is similar to the exclusive negotiated deals case with insurers offering contingent claim D only when $c = 0$, as consumers will then take out insurance for any small risk.

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. Consumers are heterogenous in their taste for quality, with a fraction λ having taste parameter θ_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 in Tirole [1988, p. 96-97]. The profit-maximizing supplier will always find it in its interest to offer both qualities.

Now suppose that the consumer is risk averse with utility function $u(w) = 1 - e^{-\gamma w}$ with w denoting his wealth level and γ the parameter of risk aversion. The potential loss the consumer faces equals 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 high quality product. This gives him an incentive to eradicate the supply of the low quality product.¹⁶ Moreover, when the consumer ‘narrow brackets’ and 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 in which the supplier provides both products.¹⁷ In that case, the insurer can offer full compensation to the supplier: The supplier and insurer maximize their joint profits by offering only the high quality product while consumer surplus is higher in the situation where both products are available.

That said, consumers may not narrow bracket 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. The insurer may then still benefit when only the high quality product is supplied but joint profits do not increase.

III(ii). *The Dutch Windshield Repair Market*

One way for insurers to influence loss sizes is by contracting preferred suppliers. In The Netherlands, some fifty insurers offer insurance for windshield repair (including windshield replacement) and the total annual cost of windshield repair is about €150 million (Consumentenbond [2012]). Virtually all insurers have contracted preferred suppliers, either directly or through a

¹⁶ In the appendix, 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 $\gamma = 0.9$.

¹⁷ Evidence suggest that people often do narrow bracket (Read *et al.* [1999]; Gottlieb and Mitchell [2019]) and it is conceivable that people have different mental accounts for expenditures on consumption items and insurance.

trade association. An insured consumer has compelling incentives to use a preferred supplier. A typical policy has no deductible in case of windshield repair by a preferred supplier while it is reduced by 50% if the windshield needs to be replaced. Also, using the services of a preferred supplier does not affect the no-claim discount, and it is customary for preferred suppliers to take care of all the paperwork. This makes it quite difficult for an independent windshield repair shop to attract customers.¹⁸

The market for windshield repair is highly concentrated with one dominant repair shop having a market share of about 50%, almost ten times as large as the second-largest shop (Hinloopen [2010]). Each insurer has its own set of preferred suppliers, but the dominant supplier is contracted by all insurers. Although windshield repair has many features of a homogeneous product, both the dominant service supplier and insurers emphasize that quality differences rule the selection of preferred suppliers. Indeed the dominant repair shop charges much higher prices than (independent) competitors. For instance, replacing a windshield of a Toyota Auris would typically cost about €250, whereas the dominant repair shop charges €494. And repairing a crack in a windshield costs €77, compared to the average market price of €35 (Consumentenbond [2012]).

These substantial price differences in combination with the large market share of the dominant repair shop suggest that it enjoys market power. Apparently, individually or jointly the insurers do not manage to reduce the prices charged by the dominant repair shop. But do they have an incentive to actually do so? The model in the preceding section suggests that insurers may have incentives to phase out 'lower quality' repair shops that charge lower prices for comparable services. The reason is that every cost reduction also reduces the risk to which the uninsured are exposed, which directly threatens the existence of this insurance market.

IV. EXPERIMENTAL DESIGN AND RESEARCH HYPOTHESES

Our experiment consists of two stages, a risk elicitation stage (Stage I) and a market stage (Stage II). Stage I is designed to elicit subjects' individual level of risk-aversion. Subjects play this stage in isolation and this stage is the same in all treatments. In Stage II subjects play a market insurance game in groups of 6 (monopoly) or 7 (duopoly) subjects. Five subjects are randomly assigned the role of consumer and the other one or two are assigned the role of

¹⁸ For example, on March 24, 2010, an independent windshield repair shop was informed by an insurer that [personal letter, translated from Dutch]: 'Windshield repair jobs will only be reimbursed for repair shops that are selected by us. Your company is not in this category. Consequently, as of May 1st we will not reimburse repair jobs that have been carried out by your shop. In case a customer has his windshield replaced by your shop, we will increase his deductible by euro 500.'

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 one monopoly treatment and two duopoly treatments.¹⁹

IV(i). *Stage I: Risk Elicitation*

The first stage 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 describe the probabilities of the outcomes.²⁰ Each subject is presented with a screen containing a 6×2 payoff matrix such as shown in Figure 2. In each row, subjects choose between option A or option B. The lottery headed under 'Option B' is always degenerate: when selected, a sure payoff is received.²¹ In Stage II 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, option B in the last row, and will switch from A to B in one of the intermediate rows. We however do 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)-combination with $L = 4, 8, 12, 16, 20$, $R = 2, 4, \dots, 18$, and $R < L$. In total, subjects thus make 150 (300) decisions in Stage I.

Laboratory studies commonly estimate (individual) risk preferences by presenting subjects with different sets of lotteries constructed by the researcher, a procedure we follow in Stage I.²² 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 what extent are insurer-subjects able to learn the risk attitudes of their population of potential buyers and to offer loss size/

¹⁹ The exact instructions for all treatments can be found in the online supplement to this article at Appendix E.

²⁰ 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.

²¹ 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.

²² Examples include McClelland *et al.* [1993]; Abdellaoui *et al.* [2011]; Andreoni and Sprenger [2012]. Risk preferences have also been estimated in the field (Harrison *et al.* [2007]; Dohmen *et al.* [2010]) or using field data (Cohen and Einav [2007]; Ericson *et al.* [2015]).

Maak voor ieder van onderstaande situaties een keuze tussen optie A en optie B

Optie A	Optie B	keuze
<p>€20 met kans 100% €12 met kans 0%</p>	<p>€ 16 met kans 100%</p>	☐ A ☐ B
<p>€20 met kans 80% €12 met kans 20%</p>	<p>€ 16 met kans 100%</p>	☐ A ☐ B
<p>€20 met kans 60% €12 met kans 40%</p>	<p>€ 16 met kans 100%</p>	☐ A ☐ B
<p>€20 met kans 40% €12 met kans 60%</p>	<p>€ 16 met kans 100%</p>	☐ A ☐ B
<p>€20 met kans 20% €12 met kans 80%</p>	<p>€ 16 met kans 100%</p>	☐ A ☐ B
<p>€20 met kans 0% €12 met kans 100%</p>	<p>€ 16 met kans 100%</p>	☐ A ☐ B

Volgende bladzijde

Figure 2

Example of a Stage I Multiple Price List Decision Screen

Notes: The text invites subjects to ‘Make a choice between Option A and Option B for each choice situation.’ ‘met kans’ means ‘with probability.’ [Colour figure can be viewed at wileyonlinelibrary.com]

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 also illuminates the issue of 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.

IV(ii). *Stage II: The Market Insurance Game*

The second stage lasts for 30 periods. Subjects are randomly matched into separate markets of six or seven subjects, without rematching between periods (partner design). Subjects with the role of consumer are given an initial endowment of $W = €20$. In each period, the insurer-subjects set a premium R_i and a loss size L_i , both in the range $[0, W]$ ($i = 1, 2$). In order not to impose a lower bound on the loss sizes set by insurers, insurers can reduce the loss size

without incurring any additional cost. By paying the premium to the insurer, consumers are protected against the event of a loss. Losses occur with an exogenously given probability $p = 0.60$.²³

Monopoly Treatment

In treatment MONOP_{UL} , the monopolistic insurer-subject sets a loss size L_1 and this also determines the potential loss faced by the uninsured: $L^U = L_1$. After having learnt the premium and the potential loss L^U , consumers decide whether or not to insure. This experimental setting is akin to the extreme case in which the insurer has full loss manipulating power *vis-à-vis* the supplier, but does not have the ability to price discriminate between those who buy insurance and those who do not buy insurance. In practice, this may happen when the insurance company is vertically integrated with the upstream market.

Duopoly Treatments

In the uniform loss duopoly treatment DUOP_{UL} , the potential loss for the uninsured is equal to the best (i.e., lowest) price set by the insurers: $L^U = \min\{L_1, L_2\}$. That is, uninsured consumers will always select the cheapest service supplier and do not incur any search cost. In the loss discrimination treatment, it is exogenously set at the maximum level $L^U = 20$ in DUOP_{LD} .²⁴ Figure 3 shows an example of a decision screen consumers may face in Stage II of DUOP_{UL} . 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 for competing insurers to undercut the rival's loss size, giving the competitive outcome of Proposition 2 its best shot.

Payoffs. All subjects were paid one randomly chosen Stage I decision. The subjects' earnings in Stage II are determined as follows. In each Stage II 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.

²³ *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 online Table D.1). In this way, we examined whether, for given loss sizes, insurer-subjects are 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. We also ran a number of sessions with a smaller loss probability of $p = 0.20$ (Sessions 4, 7 and 12 in online Table D.1). The results are available upon request.

²⁴ For competing expected-profit maximizing insurers, $L^U = L_{Max}$ is the optimal level. This parameter is set exogenously in order to keep the decision problem for insurer-subjects tractable.

ronde: **1 - 3**

rol: **consument**

Mogelijke schade indien onverzekerd: 1
 Kans op schade: 60%
 Premie verzekeraar 1: 0.5
 Premie verzekeraar 2: 12.0
 Maak uw keuze

☐ niet
 ☐ verzekeraar 1
 ☐ verzekeraar 2

Maak uw keuze
en druk op
<OK>.

<p>optie A (niet verzekeren)</p> <p>optie B (verzekeraar 1, premie 0.5):</p> <p>optie C (verzekeraar 2, premie 12.0):</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <div style="display: flex; justify-content: space-between;"> €20 met kans 40% €19 met kans 60% </div> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <div style="display: flex; justify-content: space-between;"> €19.5 met kans 100% </div> </div> <div style="border: 1px solid black; padding: 5px;"> <div style="display: flex; justify-content: space-between;"> € 8.0 met kans 100% </div> </div>
--	---

Figure 3

Example of a Stage II Consumer Decision Screen in the $DUOP_{UL}$ Treatment

Notes: [translations from Dutch:] schade = loss size; kans op schade = loss probability; Premie verzekeraar = premium charged by insurer; maak uw keuze en druk op <OK> = please decide and press the <OK>-button; niet verzekeren = not buy insurance; met kans = with probability. ronde = period (1-3 means 'period 3') [Colour figure can be viewed at wileyonlinelibrary.com]

Insurer i 's profits equal R_i times the number N_i of consumers that bought insurance from him minus L_i times the number of realized losses among his insurees.

For consumer-subjects, one randomly selected Stage II period is paid out. For insurer-subjects we decided on a different payoff structure. 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 be a period in which a high number of an insurer's insurees 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 more as risk-neutral agents because the impact of an individual random draw on their final earnings becomes small.²⁵ We used a 1:1 conversion rate of euros in the experiment to euros paid.

²⁵ In principle, we could have selected those subjects who show the most risk-neutral behavior in their Stage I decisions. However, this would lead to certain selection issues. Moreover, as a practical point, it would have urged us to process the Stage I results in the short time between the end of Stage I and the start of Stage II. Since this would necessitate some estimation of individual risk parameters, this is infeasible, even if one automates the process.

IV(iii). *Research Hypotheses*

Table I summarizes the theoretical equilibrium predictions for the experimental monopoly and duopoly markets, derived under the assumption that consumer-subjects are risk-averse and insurer-subjects are risk-neutral. These predictions are the research hypotheses of our experimental investigation. We briefly discuss each market structure-loss discrimination configuration.

Monopoly Market with Uniform Loss (Monop_{UL})

A monopolistic insurer without the ability to loss discriminate has an incentive to keep the potential loss L_1 above level L_c in order to retain a market for his product. Proposition 1 predicts that he will set L_1 to the maximal value, $L_{Max} = 20$. Given risk-averse consumers, the profit-maximizing premium will be $R_1(L_{Max}) > pL_{Max} = 0.6 \times 20 = 12$, with the exact value depending on the degree of risk aversion. This prediction corresponds in Figure 1 to contingent claim M_L for the insured and A for the uninsured.

Duopoly Market with Uniform Loss (Duop_{UL})

In the uniform loss duopoly market, competition will push back loss sizes to the point $L_1 = L_2 = L_c$, 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 $R_1 = R_2 = p \times L_c$. 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 C_c in Figure 1.

Markets with Loss Discrimination (Monop_{LD} and Duop_{LD})

In markets with loss discrimination, negotiated discounts are not available to uninsured consumers; they continue to face a potential loss of $L^U = L_{Max} = 20$. In the experiment, the parameter L^U does not enter as a choice variable for the insurer-subjects but is exogenously set at 20, the level that is optimal for the insurers. 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 discounts. 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, the insurer has an incentive to set L_1 as low as possible, that is, equal to 0. 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 M_L for the insured. We do not experimentally implement this treatment because the only predicted difference with treatment MONOP_{UL} is the higher profits for the insurer-subjects (see Table I).

TABLE I
RESEARCH HYPOTHESES ON THE PREDICTED OUTCOMES IN THE EXPERIMENTAL MARKETS

Treatment dimension		Theoretical predictions				Treatment information		
(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)
Loss discr.	Market structure	Cont. claim	Profit insurer(s)	Loss size uninsured L^U	Premium $R(L^U)$	Cons. pref.	Exp. treatment	no. mkts.
No	Monopoly	M_L	$\Pi_{UL} (< \Pi_{LD})$	$L_{Max} = 20$	> 12	$I \sim NI$	Monopol _{UL}	11
Yes	Duopoly	C_c	0	L_c	$0.6 \times L_c$	$I \sim NI$	Duopol _{UL}	8
	Monopoly	M_L	$\Pi_{LD} > 12$	$L_{Max} = 20$	> 12	$I \sim NI$	-	-
	Duopoly	D	0	$L_{Max} = 20$	0	$I > NI$	Duopol _{LD}	9

Notes: (Risk-averse consumers, loss probability $p = 0.6$).

In duopoly markets DUOP_{LD} , the fact that uninsured consumers continue to face a potential loss of $L_{\text{Max}} = 20$ ensures that the insurance market will not erode. Indeed, the exclusivity of negotiated discounts lifts the constraint that prevents insurer-competition in DUOP_{UL} to push loss sizes to zero. 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.

In sum, the consumer welfare implications of insurers having the power to manipulate the loss size, combined with the possibility to loss discriminate and insurer competition, depend on whether or not the market is an insurance market by nature. If not (that is, $L_0 < L_c$), insurers cannot bring benefits and their presence increases the loss the uninsured face (Table I, column V). However, insurer competition will ensure that consumers can buy insurance at the fair price. When insurers lack the ability to loss discriminate between insured and uninsured individuals, the resulting premium will be positive, and will depend on L_c ; when insurers can loss discriminate, in equilibrium consumers can buy insurance at zero premium (column VI). In both cases, however, they do buy a product that they previously did not need.

In insurance markets (that is, $L_0 \geq L_c$), consumers may benefit from the presence of insurers, with the size of these benefits increasing with the initial loss size L_0 and depending on the market structure-loss discrimination configuration. Without competition, the insurer's only service is to offer a transfer of risk. Consumers will not be better off because the insurer will not reduce potential losses and charge them the maximal possible premium (column VI). This is independent of the insurer being able to loss discriminate. Introducing competition erodes the insurers' profits (column IV), but in their quest for lower premiums, insurers will push the suppliers' prices all the way down to the lowest level L_c at which the insurance continues to exist. Both the loss discrimination and uniform loss case lead to an equilibrium in which consumers have a (weak) preference to buy insurance. Consumers are however better off in the former situation because of the lower insurance premium (zero) in equilibrium (column VI).

V. EXPERIMENTAL PROCEDURE AND DATA

The experiment was conducted at the CREED experimental laboratory of the University of Amsterdam. Sessions lasted between 1h25m and 1h50m. We ran a total of twenty sessions in which a total of 245 subjects participated in 45 separate markets.

Table II 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. The risk elicitation

TABLE II
SUMMARY STATISTICS SUBJECTS (STANDARD DEVIATIONS IN PARENTHESES)

	MONOP _{UL}		DUOP _{UL}		DUOP _{LD}	
	Insurers	Consumers	Insurers	Consumers	Insurers	Consumers
Role:	(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)
RISK ELICITATION STAGE						
$\hat{\gamma}_i$ median	0.029	0.081	0.089	0.083	0.082	0.095
mean	0.029 (0.061)	0.091 (0.079)	0.200* (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)
FINAL EARNINGS (IN €)						
Total earnings [‡]	29.74 (10.69)	25.70 (3.12)	12.87*** (3.68)	29.02** (1.98)	36.50 ^{†††} (9.98)	28.52 (4.88)
Risk elicitation stage	16.00 (4.20)	- (-)	14.12 (6.30)	- (-)	14.67 (6.17)	- (-)
Market stage	13.74 (8.21)	- (-)	-1.26*** (3.11)	- (-)	21.83* ^{†††} (9.49)	- (-)
# subjects	11	55	16	40	18	45
# markets		11		8		9

Notes: [‡]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_{UL} at the 1%-level (5%-level, 10%-level);

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

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_{UL}. However, in the competitive insurance market with loss discrimination DUOP_{LD}, they earn significantly more, on average €21.83. As we will see, insurer-subjects in DUOP_{LD} use their loss discriminating ability to set the cost to redress losses among their insured 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 $DUOP_{UL}$ and $DUOP_{LD}$, consumer-subjects leave the lab with more money than in $MONOP_{UL}$. In the next section, we will study in greater detail the underlying behaviors that have caused these outcomes.

VI. EXPERIMENTAL RESULTS

We split the discussion of our results into three parts. In Section VI(i) 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 balance of our design, 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 VI(ii) 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 I.

The type of decisions consumer-subjects 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 with the options offered by another subject in their market. Any observed difference in behavior indicates that subjects have a different attitude towards choosing between risky prospects and insurance choices. Section VII presents an elaborate analysis of these issues.

VI(i). *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.²⁶ For ease of comparison,

²⁶ Motivated by their research objectives, von Gaudecker *et al.* [2011] also incorporates loss aversion and time preferences for uncertainty resolution in the utility specification. In our study, neither of the lotteries *A* and *B* involves a loss, subjects receive immediate feedback on whether or not a loss has occurred, and in all cases subjects get paid immediately after the experiment has ended.

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

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

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 π_j^A and π_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:

$$(2) \quad \pi_j^A = (A_j^{low}, A_j^{high}, p_j^{high}); \quad \pi_j^B = B^{cert}$$

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

$$(3) \quad Y_{ij} = \begin{cases} 1 & \text{if the individual chooses } B \\ 0 & \text{otherwise.} \end{cases}$$

The corresponding certainty equivalents are:

$$(4) \quad CE(\pi_j^A, \gamma_i) = -\ln(-\gamma_i u(\pi_j^A)) / \gamma_i \text{ and } CE(\pi_j^B, \gamma_i) = B_j^{cert}.$$

with

$$(5) \quad \begin{aligned} u(\pi_j^A) &= p_j^{high} u(A_j^{high}) + (1 - p_j^{high}) u(A_j^{low}) \\ &= -\left(\frac{p_j^{high} e^{-\gamma_i A_j^{high}}}{\gamma_i} + \frac{(1 - p_j^{high}) e^{-\gamma_i A_j^{low}}}{\gamma_i} \right) \\ &= -\frac{1}{\gamma_i} \left[p_j^{high} e^{-\gamma_i A_j^{high}} + (1 - p_j^{high}) e^{-\gamma_i A_j^{low}} \right]. \end{aligned}$$

Combining equations (4) and (5), the difference in the certainty equivalents of lottery A and B can be written as:

$$(6) \quad \begin{aligned} \Delta CE_{ij} &= CE(\pi_j^B, \gamma_i) - CE(\pi_j^A, \gamma_i) \\ &= B_j^{cert} + \frac{1}{\gamma_i} \ln(p_j^{high} e^{-\gamma_i A_j^{high}} + (1 - p_j^{high}) e^{-\gamma_i A_j^{low}}) \end{aligned}$$

We follow von Gaudecker *et al.* [2011] in our further econometric implementation.²⁷ Whereas a perfectly rational decision-maker selects π_j^B if and only if $\Delta CE_{ij} > 0$, we allow for uncertainty by adding Fechner errors ϵ_{ij} to the deterministic economic model (see, e.g., Loomes [2005]). The decision problem of the individual now reads:

$$(7) \quad Y_{ij} = \mathbb{I}(\Delta CE_{ij} + \tau \epsilon_{ij} > 0) \text{ with } \tau \in \mathbb{R}_+,$$

with $\mathbb{I}$ denoting an indicator function. If $Y_{ij} = 1$, individual i chooses to buy insurance when faced with choice situation j . The individual's probability to make 'mistakes' (e.g., due to inattention) increases with the parameter $\tau \in \mathbb{R}_+$. We use this procedure to back out the individual-specific risk-preference parameter γ_i , whereas von Gaudecker *et al.* [2011] try to retrieve the distribution of this parameter. We estimate for each session separately the parameters τ and the individual γ_i 's by maximum likelihood.

It is reassuring that with a median value of 0.082 and a mean value of 0.103, the resulting distribution is very similar to the population distribution estimated by von Gaudecker *et al.* [2011, Figure 4a].²⁸ Reassuringly for the success of our randomization, Table II 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_{UL} are moderately more risk averse ($p = 0.068$) than those in MONOP_{UL} .²⁹ For DUOP_{UL} , a regression however does not indicate a relation between insurer risk attitudes and the minimum premium available to consumers in the market stage.³⁰ Finally, it turns out that subject choices in the risk-elicitation stage are very consistent, such that individual differences in $\hat{\gamma}$'s correctly reflect underlying differences in individual risk-preferences.³¹

VI(ii). *The Market Insurance Game*

In this section, we will present the treatment effects on the key outcome variables of the market stage of the 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

²⁷ More details are provided in the Online Appendix.

²⁸ Online Figure D.1 shows the full distribution of the estimated individual risk preference parameters of the subjects in our sample. von Gaudecker *et al.* [2011] impose more structure and do not estimate individual γ_i 's. For these reasons their distribution is smoother than ours.

²⁹ In part, this difference is explained by the lower fraction of females in treatment MONOP_{UL} ; in line with the literature on this topic (Croson and Gneezy [2009]), a regression of individual risk aversion ($\hat{\gamma}_i$'s) on gender shows a highly significant correlation between being female and risk aversion ($\beta = 0.061$; $p < 0.001$)

³⁰ We regressed the average minimum market premium on the insurer's estimated γ 's while clustering at the market level.

³¹ See online appendix C for additional analysis.

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 market stage. This procedure provides us with a map for the aggregate demand for insurance at the treatment level.³² These maps are shown in Figure 4. 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 larger 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_{UL} , 89% of all subjects decided to buy insurance (i.e., they chose Option B) when options A and B corresponded to $(R, L) = (4, 8)$.³³

There are a number of important points to take away from these maps. First, in line with the individual estimates of risk preferences, a majority of consumer-subjects shows risk-averse behavior. For example, in all treatments, most subjects decide to buy insurance at a premium of eight to be safeguarded against a 60% probability of losing twelve. 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 16.³⁴

In sum, if the decisions of consumer-subjects in the market stage of this experiment are consistent with their first stage elicited risk-preferences, 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_{UL} are able to uncover the particular iso-profit map of their market and to set the loss size and premium at the profit-maximizing levels.

Monopoly Market with Uniform Loss

In Table I we hypothesize that monopolistic insurers in a market with uniform loss MONOP_{UL} will design a contingent claim M_L such that the premium exceeds 12, the uninsured face a loss size of 20 and expected profits π_{M_L} are strictly positive. The results in Table III provide empirical support. When we

³² 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.

³³ This particular combination corresponds to the fourth choice situation in Figure 2.

³⁴ We provide a numerical example for MONOP_{UL} : at a premium of 14 and a loss size of 20, 37 subjects out of the 55 consumer-subjects (67%) 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 profits of $(48/55) \times (12 - 0.6 \times 16) = 0.35$.

(a) $MONOP_{UL}$

(b) $DUOP_{UL}$

(c) $DUOP_{LD}$

Figure 4

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 percentage 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. The labels to the iso-profit lines show the per. contract expected profits. The plots were created in Matlab using the *interp2* function for interpolation of the gridded data. The solid line is the risk neutral line. [Colour figure can be viewed at wileyonlinelibrary.com]

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 ($p < 0.001^{35}$) and, correspondingly, the average

³⁵ p -values in this section are based on one-sided t -tests, unless stated otherwise. Throughout our statistical analysis of market stage decisions, we use the market as the unit of observation.

TABLE III
MAIN EXPERIMENTAL OUTCOMES (MARKET LEVEL STANDARD DEVIATIONS IN PARENTHESES)

	1-15			16-30		
Periods	MONOP _{UL}	DUOP _{UL}	DUOP _{LD}	MONOP _{UL}	DUOP _{UL}	DUOP _{LD}
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 (per period)	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 Profits Consumers (per period)	10.33 (1.83)	14.94*** (1.43)	15.18*** (1.47)	9.22 (2.12)	15.36*** (1.15)	16.21*** (1.82)
# markets	11	8	9	11	8	9

Notes: *** (**, *) indicate statistically significant differences with MONOP_{UL} at the 1%-level (5%-level, 10%-level);

††† (††, †) indicate statistically significant differences with DUOP_{UL} at the 1%-level (5%-level, 10%-level). Significance based on two-sided pairwise nonparametric Mann-Whitney rank-sum tests. Unit of observation: Market.

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. The point, however, is that the uninsured face a much higher potential loss when compared to an initial loss size $L_0 = 0$.

Figure 5 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_{UL}, 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 the consumers in their market. Figure 6

(a) The average potential loss size L^U uninsured consumers face (except for $DUOP_{LD}$).

(b) Average premium set by insurers.

(c) Average percentage of all consumers that buys insurance.

Figure 5

Per Period Average Market Stage Outcomes for $MONOP_{UL}$ (triangles) and $DUOP_{UL}$ (circles) and $DUOP_{LD}$ (squares) [Colour figure can be viewed at wileyonlinelibrary.com]

Notes: The dashed lines depict the mean $\pm$ two standard error confidence intervals. The loss size for the uninsured is exogenously set at 20 in $DUOP_{LD}$ and not shown in panel (a). Instead, the price L^I insurers pay to redress the loss of their clients is shown.

shows for each treatment the average per period profits and earnings insurers, respectively consumers, can *expect* given their choices and the objective loss probability $p = 0.6$.³⁶ Panel 6a clearly shows that as the experiment progresses, insurer-subjects in $MONOP_{UL}$ learn how to attain higher profits. As a result, consumer earnings decrease over time (Panel 6b). 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.

³⁶ By 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.

Figure 6

Per Period Average Expected Insurer Profits and Consumer Earnings for MONOP_{UL} (triangles) and DUOP_{UL} (circles) and DUOP_{LD} (squares) [Colour figure can be viewed at wileyonlinelibrary.com] Notes: The expected profits and earnings are calculated assuming that consumers (insured and uninsured) experience a loss with probability $p = 0.6$.

Competitive Markets

For the duopoly markets, the hypotheses in Table I state that independent of the ability to loss discriminate, the introduction of competition will reduce expected profits to zero; with loss discrimination (DUOP_{LD}), premiums should be zero as well (with all consumer-subjects preferring coverage over staying uninsured); with uniform losses (DUOP_{UL}) 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 and less in loss sizes.

DUOP_{UL}. Figure 5 shows that the introduction of competition leads to significantly lower loss sizes and premiums (see also Table III). Table III and Figure 6 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 6 shows that in time, insurer-subjects learn how to break even in these markets. Compared to the corresponding 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 zero but remains at a significantly higher value of €7.71 ($p < 0.001$).³⁷ That is, as predicted, competition moves the contingent claim for the insured in Figure 1 from point M_L to C_c .

³⁷ 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.'

while the uninsured face contingent claim B . Importantly, insured and uninsured consumers continue to be worse off when compared to the initial state claim D .

$DUOP_{LD}$. In treatment $DUOP_{LD}$, competition in the insurance market is combined with the possibility to loss discriminate. It is exogenously imposed that uninsured consumers 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 zero (point D); in equilibrium, all consumers will prefer to buy insurance.

The results in Table III and Figure 5c confirm these hypotheses. 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, at the 10%-level they are significantly lower than in $DUOP_{UL}$ ($p = 0.083$). This difference can be attributed to the fact that, given the possibility to loss discriminate, insurers do not face the threat that pushing the loss sizes too low will erode their market. For this reason, they can 'negotiate' more fiercely in treatment $DUOP_{LD}$. Figure 6b suggests that expected consumer earnings are on average slightly higher in treatment $DUOP_{LD}$ than in treatment $DUOP_{UL}$ but this difference is statistically insignificant.

In sum, in case the potential loss to the uninsured is high, consumers are clearly better off when there is a competitive market for insurance: insurers with loss-manipulating bargaining power negotiate great deals with service suppliers 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 insurers who can influence loss sizes increases consumer welfare. On the other hand, in markets that are non-insurance markets ($L_0 < L_c$), the introduction of competition between insurers does not push premiums and loss sizes back to zero, independent of whether or not the negotiated loss sizes are exclusively available to insurees. Figure 6a 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.

VII. FURTHER CHECKS

In this section, we report additional analysis on the data that serves as a further check on our results. First, we address whether the choices made by

consumer-subjects in the risk-elicitation stage are indicative of their behavior in the subsequent market stage. Second, we consider for insurer-subjects whether there is a relation between their risk attitudes and the offers made in the market stage.³⁸

VII(i). *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.³⁹ 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 considering the consistency between the stage I and II choices of consumer-subjects.

The first part of Table IV contains the results for the 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 γ_i 's to back out for each consumer-subject i the average difference in the certainty equivalent (ΔCE) between option A and B that he or she is confronted with in Stage I. The mean of these values is reported in Table IV, as is the number of choices between option A and B that is correctly predicted when individual i 's risk preferences are represented by utility function (1) with $\gamma = \hat{\gamma}_i$. Given that the estimated γ_i 's are similar across treatments and that subjects face the same choice problems, it is no surprise to find that the mean ΔCE value and the success rate of the (in-sample) predictions is very similar across treatments: the estimated utility model predicts 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 implies that one cannot simply do a between-treatment comparison of the success rate of the realized (out-of-sample) predictions for the market stage. For this variable, Table IV indeed reveals large differences: from 65.2% in MONOP_{UL} to 95.3% in DUOP_{LD} . The high number in DUOP_{LD} is caused by the presence of the clearly unattractive option of staying uninsured (and facing a potential loss of 20). This leads to a large ΔCE in evaluating the options

³⁸ As a check on the external validity of our findings, we investigate in online Appendix B how the consumer-subjects' elicited risk attitudes relate to insurance purchases they make in everyday life.

³⁹ See the survey by Barseghyan *et al.* [2018] and the references therein.

TABLE IV
CHOICES BY CONSUMER SUBJECTS IN THE RISK ELICITATION AND MARKET STAGE ($p = 0.6$)

TREATMENT	MONOP _{UL}	DUOP _{UL}	DUOP _{LD}
I. RISK ELICITATION STAGE			
MEAN Δ CE	3.837	3.878	3.879
mean $\hat{\gamma}$	0.081	0.083	0.095
correct decisions	84.1%	83.9%	84.7%
II. MARKET STAGE			
mean Δ CE	1.550	1.165	11.296
correct decisions (predicted)	73.4%	69.1%	99.1%
correct decisions (realized)	65.2%	72.3%	95.3%
Difference (in perc. points)	-8.2	3.2	-3.8
Incorrect predictions			
insured	45.53%	28.16%	0.00%
uninsured	54.47%	71.84%	100.00%
# incorrect predictions	574	309	64
fraction incorrect predictions	0.348	0.258	0.047
obs.	55	40	45

and a correspondingly low chance that a subject makes a ‘mistake.’ As ΔCE becomes smaller, the likelihood of choosing the less preferred option by ‘mistake’ grows. The small market stage ΔCE ’s in MONOP_{UL} and DUOP_{UL} 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 for between-treatment differences in the ΔCE values of the options available to consumers. Conditional on the estimated γ_i ’s and τ ’s, and given the value ΔCE_{ij} of each offer j posed to subject i , we use (7) 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 IV shows that the predicted and actual percentage of correct decisions are relatively close in the duopoly treatments. For MONOP_{UL}, the table reveals an over-prediction 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 accounted for by random mistakes only.

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

Figure 7
 Stage II Insurance Choices Inconsistent with Estimated Stage I Risk Preferences
 [Colour figure can be viewed at wileyonlinelibrary.com]

actual behavior of consumer-subjects in the market stage, it is not informative about the direction of any bias. To investigate whether people behave as more or less risk averse when put in a market context, we next consider whether the estimated γ_i 's over- or under-predict the demand for insurance in the market stage. To this end, we plot in Figure 7 for each treatment separately the market stage decisions that are inconsistent with the individual risk preferences estimated in Stage I. Panel 7c for example shows that for DUOP_{LD} the total number of incorrect predictions is very small, and 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_{UL} , 71.8% of all incorrect predictions predict that subjects should have bought insurance whereas in practice they decided to go insured. Figure 7b reveals that in many of these cases, consumer-subjects rejected offers that were actuarially more than fair. In MONOP_{UL} , the incorrect predictions are rather evenly split between predicting buying

insurance when the subject did not and vice versa. Figure 7a also does not reveal a bias in a particular direction.

The main take away is that the elicited risk attitudes predict a subject's insurance choices in a market context reasonably well. They exhibit some inclination to make less averse choices when the insurance market is competitive. One explanation for this is that subjects expect that in a competitive laboratory environment with relatively thin markets, playing hard to get pays off in the form of receiving more favorable offers in future periods. If so, this is a limitation of the experimental set up in mimicking real-life insurance markets. It does imply that the experimental estimates of detrimental insurer market power will be conservative when subjects behave less risk averse in experimental markets than in real world markets.

VII(ii). *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, we regress for each experimental market the average minimum premium at which insurance was offered on the estimated individual risk-preference parameter of the insurer-subjects in that market. In DUOP_{LD} , the minimum market premium 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_{UL} ($\beta = -12.31$; $p = 0.237$; $n = 11$) but not in DUOP_{UL} ($\beta = -0.42$; $p = 0.679$; $n = 16$).

We established (Figure 6a) that selling insurance in MONOP_{UL} and DUOP_{LD} is far more profitable than in DUOP_{UL} . For this reason, one possible reading of the relation between market premiums and insurer risk preferences 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 III may underestimate the equilibrium values that would obtain in a setting with risk-neutral insurers selecting the offers.⁴⁰

⁴⁰ 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.

VIII. SUMMARY AND CONCLUSIONS

The question of 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 are 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 power not only to arrive at better prices but also to influence the cost structure in upstream markets, this does not necessarily lead 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 alter loss sizes in practice, and we present experimental evidence showing that insurer-subjects 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 our research contains an important policy implication and an illustration of a common misconception. It is beyond doubt that insurance increases welfare by its risk-sharing properties in markets that we characterize as insurance markets. However, in granting insurers buyer-power as a counterweight to supplier market power, regulators should pay attention to the possibly concomitant ability for insurers to manipulate loss size to the consumer's detriment, by protecting insurance markets or by creating 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, competition between insurers drives their profits to zero when insurers can influence the loss size but lack the ability to loss discriminate. 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 continue to be far above the zero lower bound. 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 continue to be wary of curbing loss sizes when this also benefits the uninsured.

APPENDIX

Proof of Proposition 1.

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

□

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 $L \geq L_c$. We assume that independent of the choices by the insurers, the uninsured face a potential loss $L \geq L_c$; the market is an insurance market. 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 $R_i = pL_i$, with L_i the price insurer i ($i = 1, 2$) has negotiated to redress a loss. 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 ϵ , 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 $L_1 = L_2 = 0$: 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 and to staying uninsured. □

*Numerical Example**Separate Evaluation Purchase and Insurance Decision*

Consider the market described in Section III. 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 θ with a fraction λ (the ‘high types’) having taste parameter θ_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 $\pi = \theta_L q_L - c_L = 0.18 - 0.08 = 0.10$, 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 γ 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 $R(x)$:

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

The insurer’s 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.

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 later he will buy insurance 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 is obtained by using (A.1), take exponentials of the left- and right-hand side and using 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 products maximizes the combined profits of the insurer and supplier.

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SUPPORTING INFORMATION

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Appendix A: Econometric Implementation

Appendix B: Consumer-subjects: Insurance Purchases Outside the Lab

Appendix C: Consistency of Choices in the Risk-Elicitation and Market Stage

Appendix D: Additional Tables and Figures

Appendix E: Experiment instructions [translated from Dutch]