Near-losses in insurance markets:

An experiment*

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Several studies report changes in risk taking subsequent to experiencing near-loss events. We disentangle strategic and non-strategic reactions to such near-losses experimentally. We observe that near-losses affect the supply and demand for insurance under strategic uncertainty but not individual evaluations.

Keywords: insurance, markets, near-losses, near-miss events, strategic uncertainty

JEL Codes: C91, D81, G22

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1 Introduction

The decision to insure against potential disasters results at least partially from whether decision makers have "nearly averted" personal damage previously. Kunreuther et al. (1978) presented field data suggesting that individuals who experience events in which, by good fortune, no flood damage is incurred, subsequently increase their willingness to take risks by allowing insurance policies to lapse. More recently, similar reactions to near-losses are reported in vignette studies on space missions (Dillon and Tinsley, 2008), cyber-attacks (Rosoff et al., 2013) and flood and hurricane risks (Dillon et al., 2011).

The cost of insuring against a loss is usually determined by supply and demand in a market. Since most markets are not perfectly competitive, strategic incentives will arise. If near-losses do not reveal new information about the size of the loss or its likelihood, rational market participants will have no reason to adjust their evaluations of the respective insurance. Their strategic bids or asks are also expected to remain unaffected, as long as the rationality of the market participants is common knowledge. If common knowledge is absent, however, the belief that the bids or asks of others may change after observing a near-loss will be enough to change bids or asks (or the belief that others believe that someone's bids or asks may change, or that others believe that someone believes that someone's bids or asks may change, and so on). The previous literature does not consider such strategic uncertainty even though it has been shown to be crucial for interaction in markets (see for example Crawford and Iriberri, 2007, and Charness and Levin, 2009, on auction behavior).

In our experiment we aim to disentangle non-strategic reactions to near-losses from reactions that are driven by strategic uncertainty. We confront subjects with a lottery gamble that may lead to a sizeable loss. There is transparency with regard to the size and the likelihood of the loss. We elicit valuations for insurance that protects subjects from the potential loss using the incentive-compatible BDM mechanism (Becker et al., 1964), which is commonly used to elicit evaluations of insurance contracts (see Jaspersen, 2016, for a survey). We compare these evaluations to bids and asks for the insurance in an open-book call market.

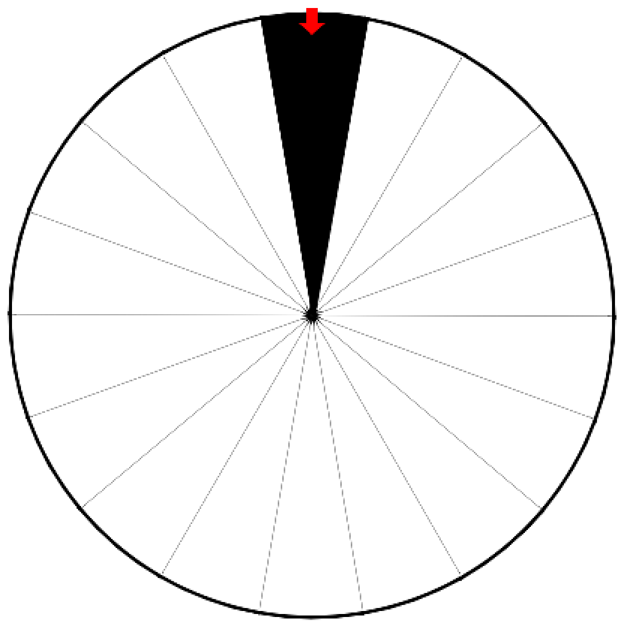
Prices for the insurance in the BDM mechanism are determined by a bid from a random number generator, while prices in the call market are the result of asks and bids chosen by other human market participants. As in the BDM mechanism, bids and asks in the call market will be driven by each individual's evaluation of the insurance. In the call market, however, they are also influenced by strategic uncertainty about the behavior of other market participants. Comparing risk taking in both conditions allows us to identify the effect of strategic uncertainty on the reactions to near-losses. We also run an open-book version of the BDM mechanism. As in the call market, there is the potential for social influence among market participants but there is no strategic uncertainty.

Recent experimental studies on asset markets have revealed that a lack of common knowledge about rationality drives the mispricing of assets. Cheung et al. (2014) observe that mispricing is substantially reduced if market participants know that all market participants have been trained extensively on the nature of the fundamental value. Training itself, however, does not affect mispricing. Akiyama et al. (2017) also study behavior in experimental asset markets. They compare the behavior of individuals facing other human traders to the behavior of individuals facing computerized traders known to behave rationally. They conclude that 50 percent of the observed mispricing was driven by strategic uncertainty caused by human traders. In an incentivized experiment conducted in parallel to our study, Wu et al. (2017) observe less risk-averse behavior after near-losses in a non-strategic betting task. Like Wu et al. (2017), we use a roulette wheel to provide participants with event cues and for resolving uncertainty (see also Kahneman and Varey, 1990, for an early discussion).

2 Experimental design

In the experiment insurance contracts against the lottery X could be traded in rounds $t = 1, \ldots, 18$. The binary lottery pays -18 experimental currency units (ECU) with a probability of 1/18 and 0 otherwise. This lottery was depicted as a roulette wheel in the experiment shown in Figure 1 (see the Appendix for complete instructions): one field yields a loss of 18 ECU while the other 17 fields do not influence payoffs. After each round the outcome of the lottery was determined by an animated wheel spin (as depicted) that highlighted which field was selected in a particular round. The loss event occurred when the wheel stopped on the black field. A near-loss event was operationalized in terms of the two fields adjacent to the black field.

Figure 1 – Roulette wheel with 18 fields



At the beginning of the experiment subjects were randomly assigned the role of a buyer or seller. In each round, sellers were endowed with an insurance contract against the lottery, while buyers were not. The lottery had an expected payoff of -1 ECU which is equal to the fair value of the insurance contract. Each round started with an actuarially equal distribution of endowments: buyers were endowed with 26 ECU and sellers with 25 ECU. Across treatments buyers stated the highest price for which they were willing to buy insurance ("bid") and sellers stated the lowest price for which they were willing to sell insurance ("ask"). Once a trade was implemented the price was subtracted from the buyer's endowment and added to the endowment of the respective seller. Subjects could hold at most one insurance contract. Those who did not hold a contract at the end of a round had to play the lottery, and any resulting loss was subtracted from their payoff for that round. At the end of the experiment one round was randomly determined for payment and ECU were converted to Euros at a rate of ECU 1 to Euro 0.80.

Table 1 summarizes the treatments. In two treatments we used the incentive-compatible BDM mechanism (Becker et al., 1964). In theory, this mechanism truthfully elicits the individual willingness-to-pay (WTP) and willingness-to-accept (WTA) of buyers and sellers.[1] More specifically, in the two BDM treatments, **BDM** and **BDM-O,** subjects had to enter the highest price for which they would buy insurance or the lowest price for which they would sell the insurance. These values were elicited using a list of potential prices, as in Bartling et al. (2015). Subjects were informed that one of the prices would be selected randomly as the clearing price. Buyers would buy the insurance if their stated bid was higher or equal to this price. Sellers would sell the insurance if the ask was equal to or below this price. The two BDM treatments were framed as a market interaction, but buyers and sellers submitted their values in the BDM mechanism privately and the outcome was determined independently for everyone. Participants in the **BDM** treatment were not informed about the actions of other participants. In the **BDM-O** treatment subjects were informed at the end of each round about the bids and asks entered by the other subjects in a matching group. Subjects in this treatment interacted in groups of eight market participants (without re-matching), equally divided into buyers and sellers. The feedback provided meant that this represented an "open-book" version of the BDM mechanism.

In the **CM-O** treatment we implemented the open-book call market (Arifovic and Ledyard, 2007). In this treatment participants also interacted in groups of eight market participants. Bids and asks were collected as sealed-bids and the market price was determined by maximizing the feasible number of trades in each round. As in the **BDM-O** treatment, participants were informed about all bids and asks in their market after each round. Note that bids and asks are the result of strategic interaction in this treatment, and cannot be regarded as willingness-to-pay or willingness-to-accept measures. Nevertheless, we can compare the adjustments of bids in **BDM**, **BDM-O** and **CM-O** over time.

All subjects participating in one matching group faced the same lottery realizations. Two orders of independent lottery realizations were used across treatments. On average, each subject experienced two near-losses and one loss in total.

Sessions lasted for 90 minutes at most and subjects earned 19.93 Euros on average. They were recruited via ORSEE (Greiner, 2015). The eight sessions were conducted at the Essen Laboratory

[1] Since the lottery we consider has a negative expected value, buyers buy insurance and state their willingness-to-pay (WTP), while sellers state their willingness-to-accept (WTA) (see Camerer & Kunreuther, 1989, for a similar wording). Of course, referring buyers of the insurance as "sellers of the lottery" would be equivalent.

for Experimental Economics (elfe) using z-Tree (Fischbacher, 2007). In each session we conducted all three treatments at a time and participants were randomly assigned to treatments.

Table 1 - Treatments

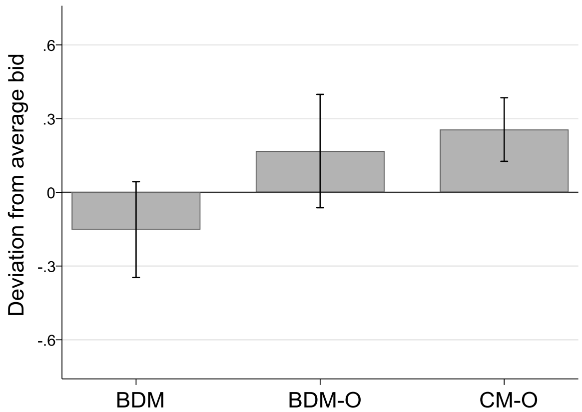
Treatment	Price determination	Feedback	Rounds	Matching groups	*N*
BDM	BDM list	None	18	-	32
BDM-O	BDM list	Order book	18	8	64
CM-O	Call market	Order book	18	8	64

3 Results

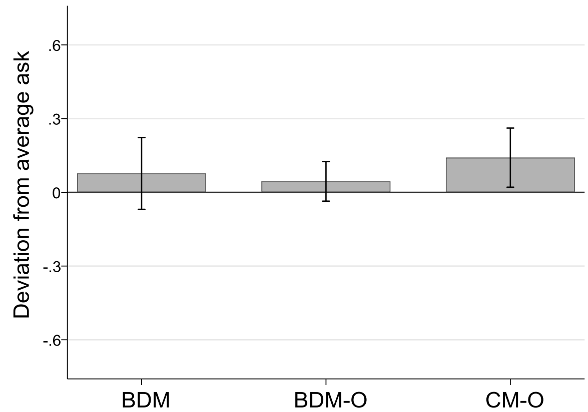
In accordance with an endowment effect which is frequently observed in experimental studies (for studies involving lotteries see, e.g., Knetsch and Sinden, 1984, Eisenberger and Weber, 1995, Schmidt and Traub, 2009), buyers' average bid (2.219) was higher than sellers' average ask (4.048). In line with risk aversion, the average bids and asks were significantly larger than one (the fair price of the insurance) in all three treatments ($p \leq 0.030$, two-sided Wilcoxon matched-pairs signed-ranks tests). The average ask is 0.427 ECU higher in **BDM** than in **CM-O** ($p=0.037$, two-sided Mann-Whitney-*U* test). There were no other significant differences in bids or asks between treatments ($p \geq 0.159$).

If subjects adjust their individual evaluations of the insurance after near-loss or loss events, we should observe a change in buyers' bids and sellers' asks in all treatments. If changes are due to strategic considerations, they should only occur in the treatment with market interaction, **CM-O**.

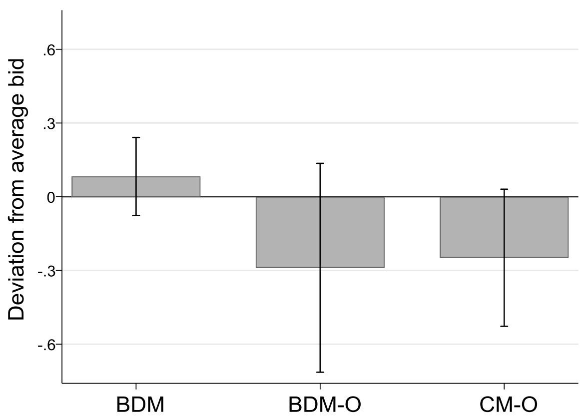
Figure 2 shows the deviation in bids and asks after near-loss and loss events compared to the average bid or ask in rounds not following a near-loss or loss event. We observe a significant increase in buyers' bids in **CM-O** of 0.256 ECU after experiencing near-loss events, indicating a decrease in risk taking ($p=0.025$, two-sided Wilcoxon matched-pairs signed-ranks tests). Similarly, sellers exhibit weakly significantly less risk taking by stating asks which are on average 0.141 ECU higher after near-loss events ($p=0.068$). We do not find significant changes in risk taking behavior in **BDM** and **BDM-O** ($p \geq 0.162$). After observing a loss, only buyers in **CM-O** decreased their bids weakly significantly ($p=0.093$). Although the change in bids is not significant for buyers in **BDM-O** (p=0.263), its tendency is again similar to that in **CM-O**. Other subjects did not adjust their bids or asks following a loss ($p \geq 0.461$).



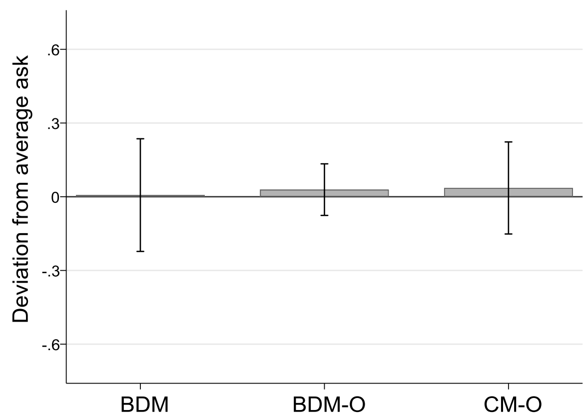
a. Deviation from average bid after near-loss events



b. Deviation from average ask after near-loss events



c. Deviation from average bid after loss event



d. Deviation from average ask after loss event

Figure 2 – Deviation from average bids or asks

after near-loss and loss events with 90% confidence intervals

We also run separate fixed effects panel regressions for buyers and sellers in each treatment. We assume that buyers i in a matching group j state their bid in round t according to

$$bid_{it} = \beta_0 + \beta_1 price_{j,t\text{-}1} + \beta_2 near\_loss_{j,t\text{-}1} + \beta_3 loss_{j,t\text{-}1} + \alpha_i + \varepsilon_{it}. \quad (1)$$

The bidding function contains the last round's price ($price_{j,t\text{-}1}$) which may serve as an anchor for bidding in the current round t. The two dummy variables $near\_loss_{j,t\text{-}1}$ and $loss_{j,t\text{-}1}$ take the value 1 if buyers and sellers in market j experienced a near-loss event or loss event, respectively, in the last round and 0 otherwise. Idiosyncratic errors ε_{it} are assumed to be independently and identically distributed. We apply the same model for sellers' asks and only replace each "bid" with "ask" in (1). Table 2 shows the results.

Table 2 – Regressions for buyers' bids and sellers' asks

	Buyer			Seller		
	BDM (1)	**BDM-O** (2)	**CM-O** (3)	**BDM** (4)	**BDM-O** (5)	**CM-O** (6)
$price_{j,t\text{-}1}$	0.014	0.007	0.090**	0.030	0.055**	0.016
	(0.032)	(0.031)	(0.041)	(0.020)	(0.022)	(0.051)
$near\_loss_{j,t\text{-}1}$	-0.149	0.168	0.233**	0.084	0.044	0.137*
	(0.114)	(0.118)	(0.095)	(0.084)	(0.052)	(0.075)
$loss_{j,t\text{-}1}$	0.093	-0.294*	-0.259	0.028	-0.009	0.034
	(0.092)	(0.168)	(0.186)	(0.122)	(0.080)	(0.102)
Constant	2.004***	2.400***	2.106***	4.147***	3.758***	3.756***
	(0.091)	(0.065)	(0.138)	(0.052)	(0.048)	(0.171)
Observations	272	544	544	272	544	544
Number of subjects	16	32	32	16	32	32
F-test	1.165	1.674	3.376	3.740	3.030	1.285
Prob>F	0.356	0.193	0.0307	0.0345	0.0441	0.297
BIC	433.7	1508	1160	295.8	978.5	1212

Notes: Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Consistent with our non-parametric tests, regressions show an increase in bids and asks – or a decrease in risk taking – after experiencing near-loss events in **CM-O,** but not for buyers' and sellers' evaluations in **BDM** and **BDM-O**. This suggests that the strategic uncertainty of the market environment drives behavioral responses to experiencing near-loss events. The increase in average bids subsequent to near-losses is in fact significantly greater for buyers in **CM-O** than in **BDM** (p=0.006, two-sided Mann-Whitney-U test). Since there are no significant differences between **CM-O** and **BDM-O** (p=0.528), however, the decrease in risk taking in **CM-O** may be at least in part attributable to feedback about other bids and asks in the market (see, e.g., Trautmann and Vieider, 2012, for a survey on social influences on risk taking).

The tendency for less risk taking following a near-loss in **CM-O** appears to contradict previous work by Dillon and Tinsley (2008) as well as by Tinsley et al. (2012), who observe an increase in risk taking subsequent to experiencing near-loss events. However, studies conducted in these papers are substantially different as they rely on hypothetical, vignette-based decision scenarios and do not consider social influences or strategic uncertainty.[2] Taking this into account, our findings are broadly consistent with previous results by Wu et al. (2017). Focusing only on individual decisions, the authors also employ an incentivized task using a roulette wheel. They observe more risk-averse behavior if the roulette wheel stops just *before* the loss and less risk-averse behavior if it stops just *after* the loss. The near-losses in our experiment resemble their "before near-loss" conditions. This was not a conscious design-choice but resulted from the specific time-series of random spins generated in our experiment.

4 Conclusion

To our knowledge we present the first study analyzing near-loss events using the tools of experimental economics. Our experiment reveals that strategic uncertainty influences risk taking subsequent to experiencing near-losses. In our setting, we do not observe a significant effect from near-losses on individual evaluations of insurances as measured using the BDM mechanism. However, we observe an increase in bids for insurances and – to a smaller degree – an increase in asks in a call market with strategic uncertainty. It is important to note that this effect may also be influenced by competitiveness or other aspects that are specific to a market setting, however. Although not significant, we find a tendency for a similar effect when allowing for social influences among participants when eliciting individual evaluations using the BDM mechanism. This finding suggests that also social information may contribute to the decrease in risk taking we observe in the call market.

[2] Moreover, Tinsley et al. (2012) distinguish between two types of events: Near-loss events that almost happened may increase the perceived vulnerability of a system and, hence, lead to less risk taking, whereas near-loss events that could have but did not happen may increase the perceived resilience of a system and, hence, result in more risk taking. It remains speculative, however, whether the near-loss event in our study was indeed interpreted by our subjects as an event that "almost happened".

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Appendix: Instructions (translated from German)

Welcome to the experiment!

<u>Preliminary note</u>

You are taking part in an experiment about decision making. During the experiment you and the other participants will be asked to make decisions. By doing so, you can earn money. How much you are about to earn depends on your decisions. After the experiment you will receive your earnings in cash.

None of the participants will receive any information concerning the identity of other participants during the experiment.

Instructions

Please read the following instructions carefully. Approximately five minutes after you have received the instructions, we will come to your desk to answer any remaining questions. Should you have any questions during the experiment, please <u>raise your hand</u>. We will then come to your desk to answer them.

<u>Procedure</u>

The experiment consists of 18 rounds. One of these rounds will be randomly selected at the end of the experiment to determine your payoff. In each round you own an amount of money that can be reduced by participating in a lottery. You always have to participate in the lottery but you can insure yourself against the potential loss of a round. If you are insured, you will not suffer a loss through the lottery of this round in any case.

At the beginning of the experiment it will be randomly determined whether you participate as a buyer or seller. In each round the sellers own a budget of 25 experimental currency units (ECU) and one insurance policy. The buyers own a budget of 26 ECU and no insurance policy. If the lottery results in a loss, it reduces the budget of each participant not owning an insurance policy by 18 ECU.

One round consists of a *trading phase* and a *lottery phase*. In the *trading phase* insurance policies can be bought or sold. In the *lottery phase* a spin of a wheel of fortune determines whether a loss occurs.

<u>Trading phase</u>

At the beginning of each round insurance policies against a loss from the lottery can be traded on a market. Sellers own one insurance policy each at the beginning of a round. In the trading phase they have to state whether they would sell their insurance policy at various potential price levels. Buyers do not own an insurance policy at the beginning of a round. In the trading phase they have to state whether they would buy an insurance policy at various price levels.

[*BDM/BDM-O:* In each round a new market price is drawn randomly from the interval 0 ECU to 5 ECU (including the values of 0 ECU and of 5 ECU). So note that you cannot influence the market price through your decisions.]

[*BDM-O/CM-O:* In each round you and seven other experiment participants will form a group consisting of four buyers and four sellers. The constellation of the group is determined randomly and remains the same for all rounds.] [*CM-O:* The market price is based on the lowest acceptable prices of sellers and on the highest acceptable prices of buyers. It is determined so that the largest possible number of insurance policies is traded between the buyers and sellers of your group. This happens under the condition that each participant can only own one insurance policy at the end of the trading phase. So note that you can influence the market price of your group through your decisions. (In the info-box on the last two pages of these instructions you will find further information about how exactly the market price is determined.)]

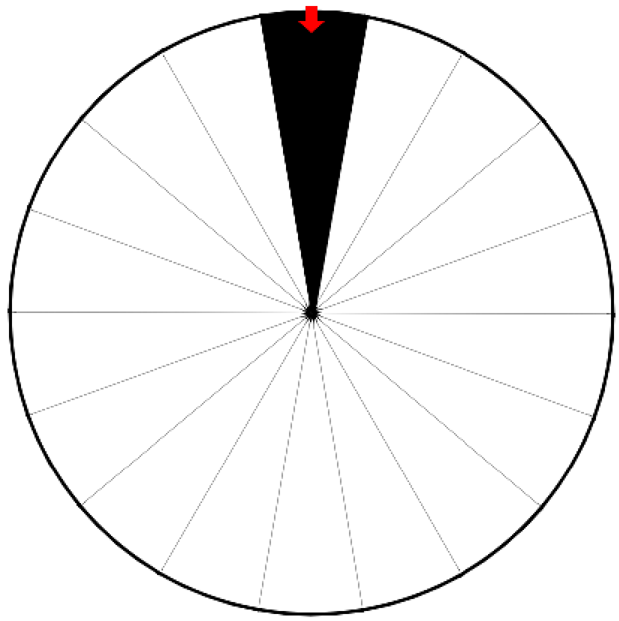
At the end of the trading phase you will be shown the market price. A trade will be realized if you have stated that you would buy or, respectively, sell an insurance policy at this price.

[*BDM-O/CM-O:* Also you will be shown an overview of the lowest acceptable prices of the four sellers and the highest acceptable prices of the four buyers in your group (ordered by size).]

Lottery phase

In the lottery phase a lottery will determine whether a loss occurs in each round, respectively. For this, a wheel of fortune such as the one in the figure below will be spun. The wheel of fortune has 18 fields, 1 black and 17 white. The wheel of fortune randomly stops at one of these 18 fields with each field being equally likely.

If the wheel of fortunes stops with a white field at the top, no loss occurs. That means the loss from the lottery is 0 ECU. If the wheel of fortune stops with a black field at the top, a loss 18 ECU occurs. The loss from the lottery is only relevant for experimental participants who do not own an insurance policy after the trading phase.



Profit calculation

After the lottery phase, the profits from a round will be calculated as follows:

- for a seller with insurance policy: 25 ECU
- for a seller without insurance policy: 25 ECU + market price – loss from the lottery
- for a buyer with insurance policy: 26 ECU – market price
- for a buyer without insurance policy: 26 ECU – loss from the lottery

Payment

At the end of the experiment one of the 18 rounds will be chosen at random and you will be paid the profit that round. 1 ECU amounts to 0.80 Euro. Payments are rounded to 0.10 Euro.

Before the first round you will participate in a short comprehension test. If you have any questions, please just raise your hand.

[*CM-O:* **Further information on the determination of the market price**

For calculating the market price all highest acceptable prices of buyers and all lowest acceptable prices of sellers will be determined first. They will then be ordered according to their size. If the highest acceptable price of all buyers is above the lowest acceptable price of all sellers, the respective buyer and the respective seller trade. If the *second* highest acceptable price of buyers is above the *second* lowest acceptable price of sellers, both market participants trade as well. The same principle applies to the third and fourth buyer-seller-pair.

So the total number of traded insurance policies is equal to the number of highest acceptable prices of buyers that are above lowest acceptable prices of sellers. Accordingly, in the market with four buyers and fours sellers at most four insurance policies can change hands.

If *none* of the highest acceptable prices of buyers is above the lowest acceptable prices of sellers, no trade takes place and there is no market price.

If *all* of the highest acceptable prices of buyers are above the lowest acceptable prices of sellers, all insurance policies will change hands. Then the market price is the average of both acceptable prices of the last trading buyer-seller-pair.

If *one*, *two* or *three* of the highest acceptable prices of buyers are above the lowest acceptable prices of sellers, one, two or three insurance policies will change hands. In this case, the market price will be determined as the average of the following two values:

(i) The lower of the following two values: The highest acceptable price of the last successful buyer and the lowest acceptable price of the first seller, who did not get to trade.
(ii) The higher of the following two values: The lowest acceptable price of the last successful seller and the highest acceptable price of the first buyer, who did not get to trade.

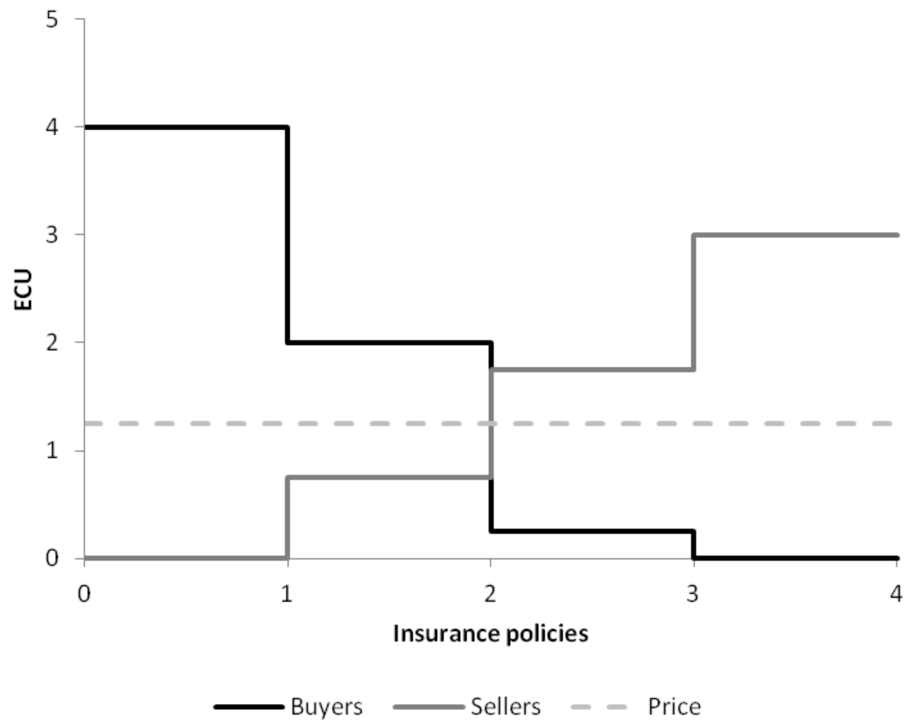
Example:

The highest acceptable prices of the four buyers are
4.00 2.00 0.25 0.00
The lowest acceptable prices of the four sellers are
0.00 0.75 1.75 3.00

In this case two insurance policies will be traded: First the pair with 4.00 and 0.00 trades and then the pair with 2.00 and 0.75. In the first buyer-seller-pair that does *not* trade, the buyer has a highest acceptable price of 0.25 and the seller has a lowest acceptable price of 1.75.

The market price is then determined as follows:
(i) The relevant value is 1.75 because 1.75 is lower than 2.00.
(ii) The relevant value is 0.75 because 0.75 is higher than 0.25.
The mean value from (i) and (ii) and therefore the market price is (1.75 + 0.75)/2 = 2.50/2 = 1.25.

The following diagram shows the highest acceptable prices of buyers and the smallest acceptable prices of sellers as well as the resulting price:



If there are multiple buyers entering the same highest acceptable price, it is determined randomly who of them trades first. In the same way, it is randomly determined which seller trades first, if multiple sellers enter the same lowest acceptable price.]